

MASS. HS30.2:H35/4



312066 0374 7036 1

Department of Public Health

Health Investigation of Residents
Living Near the Majilite and Compo Facilities
in Lowell, Massachusetts

GOVERNMENT DOCUMENTS
COLLECTION

Report of Findings
March 1, 1985

AUG 13 1987

University of Massachusetts David Ozonoff, M.D., M.P.H. 1
Depository Copy 2

Mary Ellen Colten, Ph.D.

Timothy Heeren, Ph.D.

Adrienne Cupples, Ph.D.

Thomas Mangione, Ph.D.

Julie Palmer, M.P.H.

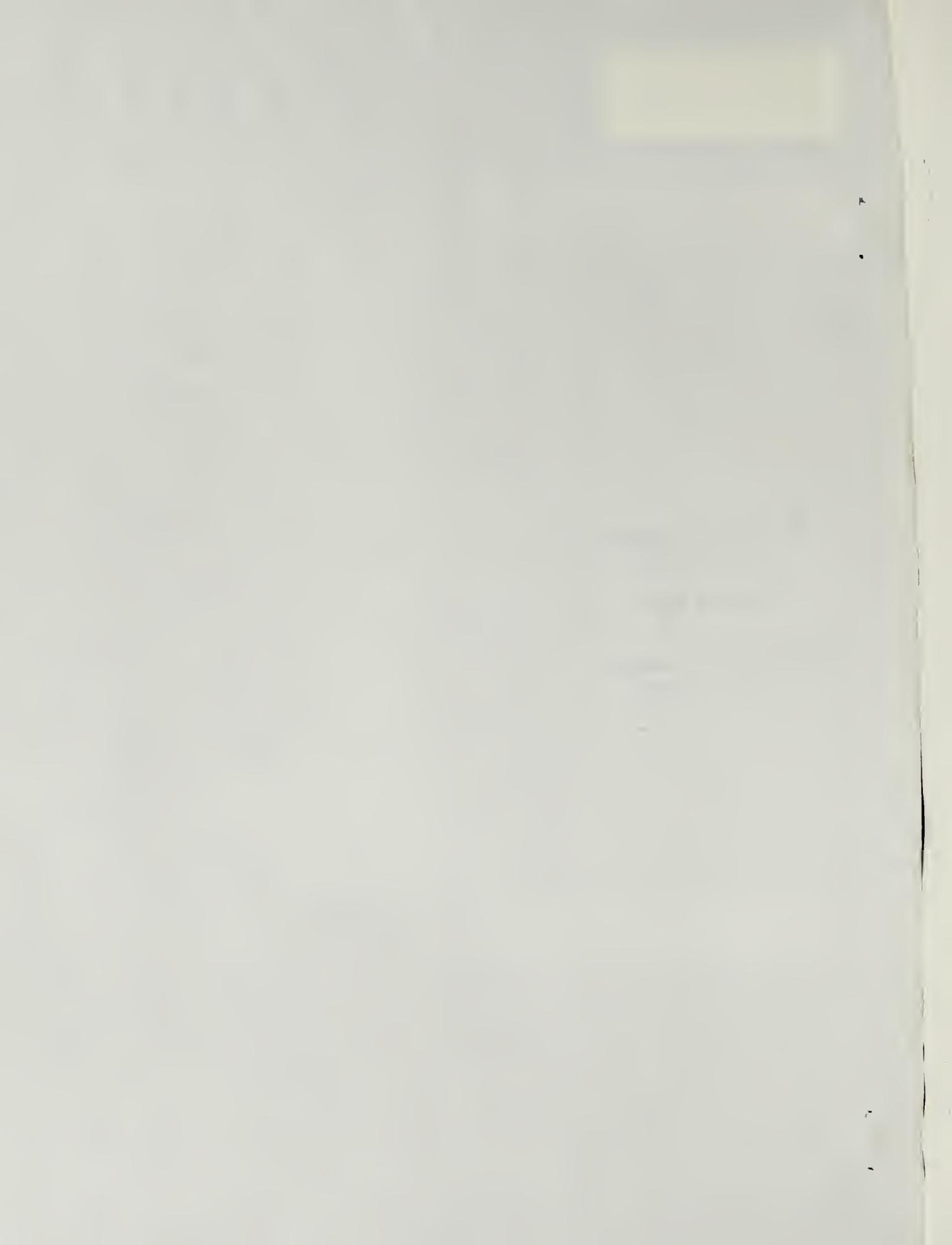
Miriam Dresner, M.P.H.

1

Boston University School of Public Health - Prime Contractor

2

Center for Survey Research, University of Massachusetts, Boston -
Sub-contractor

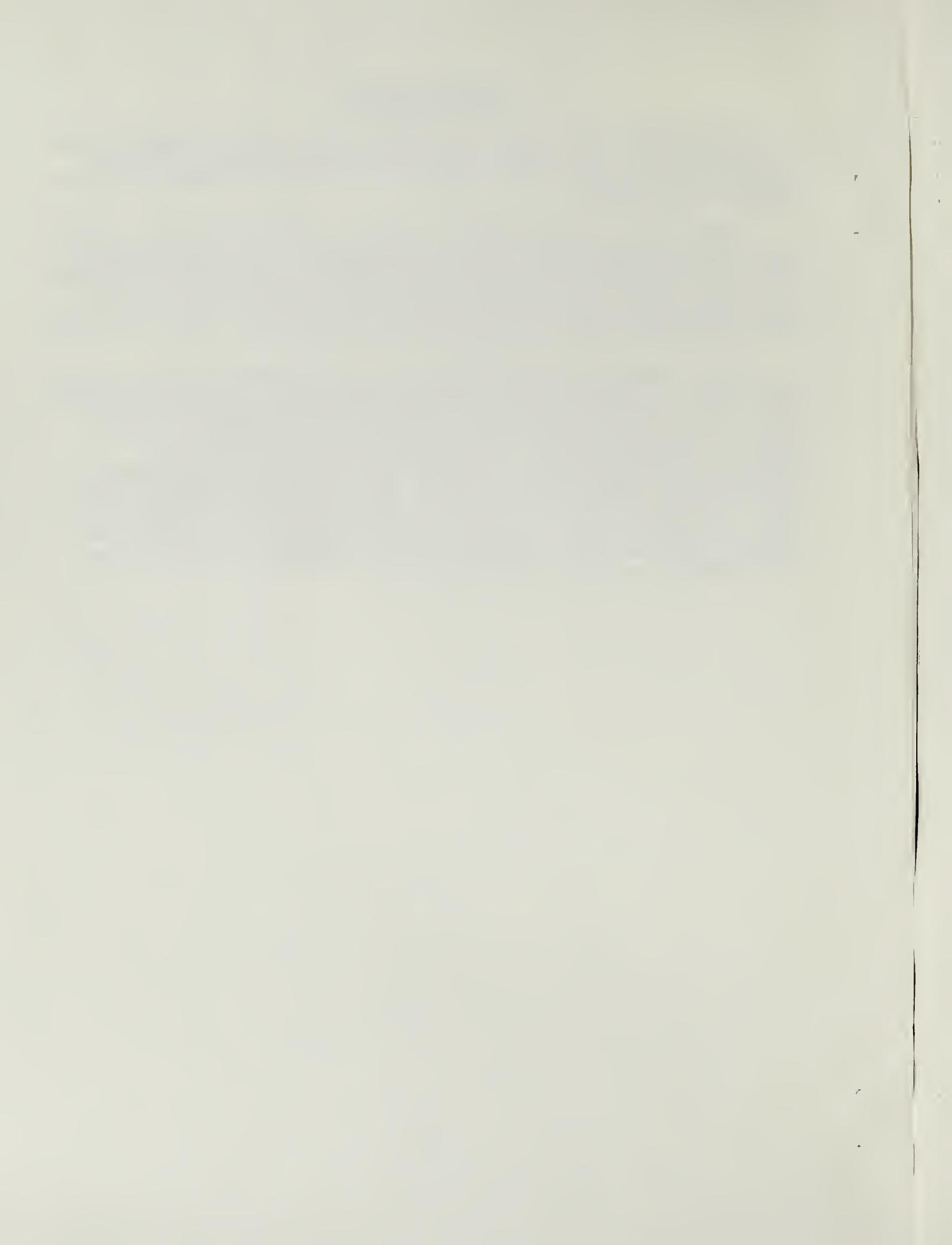


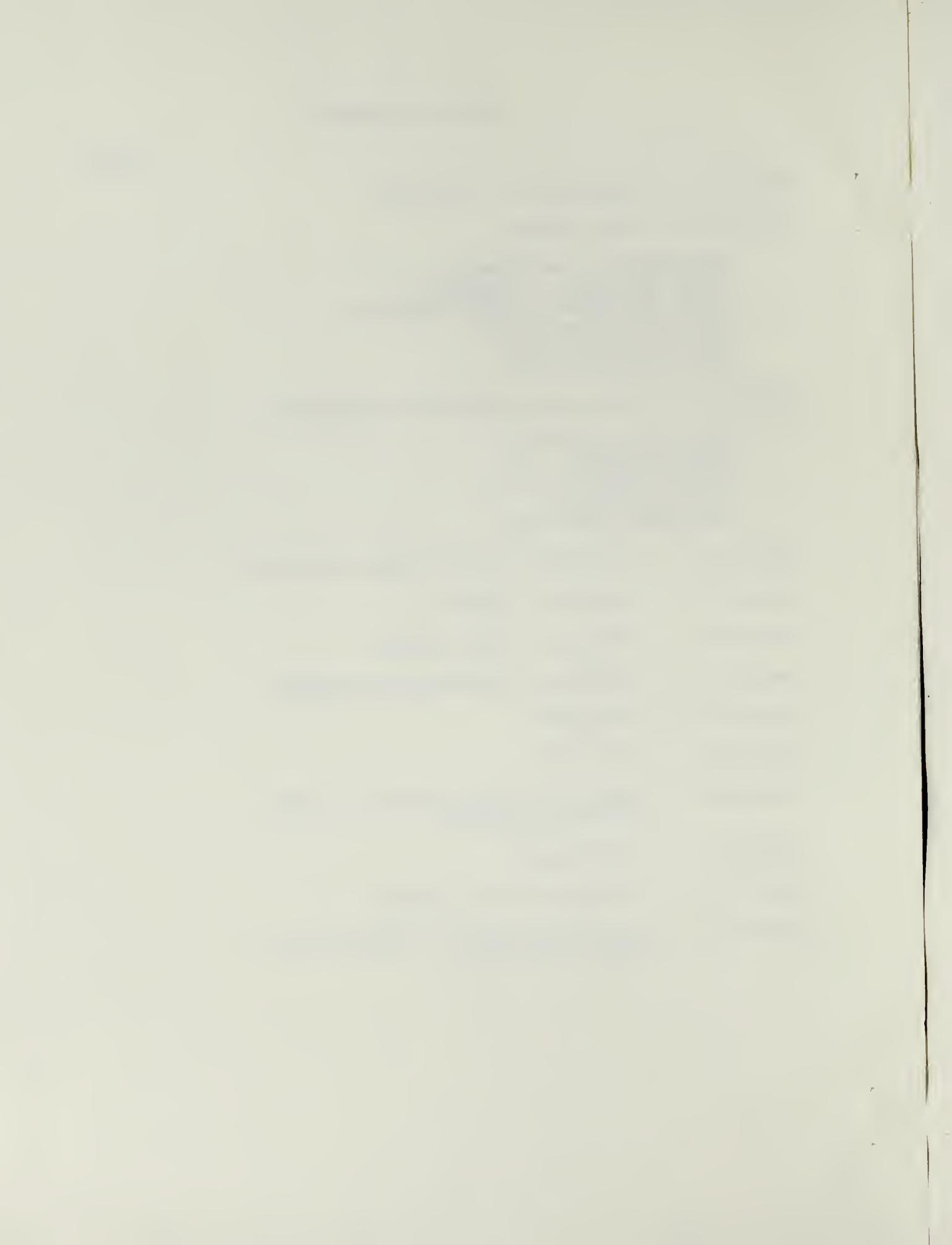
Acknowledgments

The authors would like to extend their sincere appreciation to the people in our study area who so willingly gave us the benefit of their experience and took the time to respond to our lengthy interviews.

There were a large number of people who contributed to this report that we would also like to recognize. The interviewers and staff of the Center for Survey Research carried out the field survey and coded, key-punched and cleaned the data tape. We would especially like to acknowledge the splendid work of Dorothy Cerankowski who supervised the interviewers.

Daryl Grassick of the Division of Air Quality Control at the Department of Environmental Quality Engineering ran the computer model that allowed us to make the exposure estimates in this study. We are grateful to him and the staff of DAQC for this essential contribution. Both contracting agencies, the Massachusetts Department of Public Health and the Department of Environmental Quality Engineering, gave us patient support and help. We would especially like to thank Mr. John O'Brien and Dr. Halina Brown for their advice and encouragement. Ms. Roberta Murphy typed the final report with its complex tables with her usual professionalism and dedication.





Section 1
Background of the Study

In March of 1983 ambient air monitoring studies undertaken in connection with a health survey of residents near an uncontrolled hazardous waste site (the Silresim site) revealed high concentrations of dimethyl formamide (DMF), xylene, and toluene emanating from two manufacturing facilities at a short distance from the study neighborhood. These two facilities, the Majilite and Compo factories, were situated in or very close to a residential area used for comparison purposes in the hazardous waste health investigation. DMF levels in the vicinity of the Majilite plant were in the range of 2.6 to 2.8 ppm, while in the Compo area ambient levels of DMF were approximately 1 ppm. Both facilities are located in densely populated urban neighborhoods.

The Massachusetts Department of Environmental Quality Engineering (DEQE) and the Massachusetts Department of Public Health (DPH) believed these levels to be in excess of what would be considered acceptable for the general population and DEQE therefore undertook immediate enforcement action. At the same time, DEQE and DPH judged that there was an opportunity to gather appropriate information on possible health effects of this community's exposure to airborne toxic agents and, therefore, a contract was let to the Boston University School of Public Health to amend and extend the health survey already being conducted at the nearby hazardous waste site. Information about the health of some of the residents in the neighborhood of Majilite and Compo was already available as part of the comparison data used in the Silresim investigation, and additional monies were made available to survey additional residents in the vicinities of the two factories.

Both Majilite and Compo were immediately ordered by DEQE to effect prompt reductions in DMF emissions. By the middle of June, 1983, both facilities had reduced their emissions by one-third to one-half of the original levels.

From the middle of June to the first week of August, additional interviews were conducted with residents near the Majilite and Compo plants. The survey instrument was identical to the one used previously in the Silresim waste site investigation and, therefore, the data obtained from the Silresim comparison group in the neighborhood of Majilite and Compo in February and March could be used in the present study. The additional interviews were taken in areas close to the Majilite and Compo plants where exposures had been considerably higher than those in the hazardous waste comparison group mentioned above. The interviews were conducted, however, at a time shortly after the highest exposures from these plants were abated as a result of DEQE enforcement actions.

This report presents the results from this additional study of the residents around the Majilite and Compo plants. This study follows the same cross-sectional design used in the previous study.

A faint, grayscale watermark-style image of a classical building with four prominent columns and a triangular pediment occupies the background of the page.

Digitized by the Internet Archive
in 2014

<https://archive.org/details/healthinvestigat00bost>

Section 2
Study Design

The objective of the current study was to assess the impact on the health of Lowell residents exposed to airborne contaminants emitted from two industrial facilities. A cross-sectional survey design was used to examine the relationship between exposure to the emissions, as estimated by computer modelling techniques, and the self-reporting of selected symptoms. Both acute symptoms reflecting current exposures and chronic conditions that might have resulted from past exposures were included.

Hypothesis Tested

Exposure to emissions from the two industrial facilities was associated with higher likelihood of self-reported adverse health outcomes.

Study Variables: Exposure

In February-March, 1983, data was collected on almost 3,000 residents of Lowell in an effort to assess the health impact on a neighborhood adjacent to the Silresim Chemical Corporation site, an improperly managed hazardous waste treatment and storage facility in the Ayer City section of Lowell (Figure 1). About half of the data was from individuals in a comparison group too far from the waste site to be affected by it. A portion of this comparison group, however, was near the two factories with high emissions of DMF, toluene and xylene (see Figure 2).

As a result of the discovery of these point sources, additional interviews were conducted from mid-June to the first week in August near the factories. Figure 2 shows the relationship of the areas of residence of the old Silresim comparison group to the factories and the households sampled later.

Exposure estimates for each point on a 300 x 300 meter grid were then calculated by the Division of Air Quality Control, DEQE, using emissions data obtained from the managements of each facility. The center of the grid (0,0) was on the Compo Industries facility. Receptor elevations were determined by using Lowell Quadrangle U.S. Geological Survey Topographical maps. A steady-state Gaussian plume model (the EPA ISCST model) was used to estimate 8-hour averages of DMF using the stack parameters given in Appendix 4. Rural stability classes E and F were reclassified to class D to simulate an urban setting, as recommended by EPA. Hour-by-hour surface meteorological data from Boston's Logan Airport and upper air meteorological data from Portland, Maine, for the five-year period 1977-1981 were used in the model.

Each household in the sample was then located on a map and a weighted average exposure calculated based on the nearby grid points. This average was obtained as follows. Each grid square was divided into nine equal sub-areas and the household assigned to

the proper sub-area by means of its street address. Households in any of the four squares in the corners of the grid square were assigned the exposure values calculated for the adjacent (corner) grid point. Households in any of the four squares mid-way between two grid points were assigned the mean of the two grid points. Any household in the center sub-area was assigned the average of the four corner grid points. Figure 3 summarizes this procedure.

In this way every household was assigned an estimate of exposure based on emissions and meteorologic data appropriate for the first quarter of 1983. These estimates represent a valid relative estimate of actual exposure at the time of the survey only for the first wave of interviews done in connection with the Silresim investigation in February-March, 1983. Subsequent to the discovery of the existence of these exposures in March by DEQE and DPH, enforcement actions resulted in a reported substantial reduction in emissions by mid-June, the time when the second wave of interviews was begun. This means that the actual exposures at the time of the new survey in June, July and August were probably substantially less than the estimates indicate. On the other hand, these estimates are still appropriate for gauging relative exposures in the recent and more distant past for these households. The ways that the exposure estimates are used in the analysis will be explained in detail in the appropriate sections.

Study Variables: Health Outcomes

The same broad-based health survey instrument used in the Silresim study was employed in this investigation. This was necessary to maintain consistency with data collected in that study, but was also appropriate and acceptable because the anticipated health effects differed little if at all from those which formed the basis of the earlier study. Appendix 1 gives a brief summary of the known and suspected effects of DMF, xylene and toluene, the principal contaminants from the two facilities in question.

Questions about adverse health outcomes in this study can roughly be divided into those that are of relatively short duration and those that are more chronic or of such a magnitude as to be easily remembered. In the first category are a wide variety of acute symptoms for which respondents were asked to confine themselves to occurrences only within the previous six months. In some instances, such as reasons for visits to a doctor, an interval of two months was specified. The recall decay rate for such events is unknown, however, and it may be that accurate reporting holds for only a few weeks. In the second category (longer term effects) are questions that asked if a doctor had ever diagnosed a major chronic disease, such as heart disease, or if there was a history of miscarriage, birth defects or infertility.

The self-reported health problems were generally not subject to verification. Most involved complaints such as headaches,

dizziness or fatigue, for which objective findings do not exist. Respondents were asked whether they sought medical care for these complaints, but the decision to see a doctor is influenced by many factors other than the actual existence of the complaint. In any event, such care-seeking behavior results in a documentation of a self-reported symptom with no more objective foundation than that obtained by survey methods. The answers to questions concerning whether a doctor or other health care provider had ever diagnosed certain diseases is, in principle, verifiable, but the process is time-consuming and expensive and beyond the scope of resources allotted to this study. A summary of the health outcome variables is presented in Table 2-1. The full text and explanatory phrases can be found in the questionnaire, given in Appendix 2.

Other Study Variables

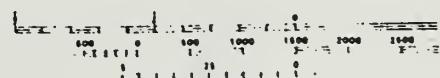
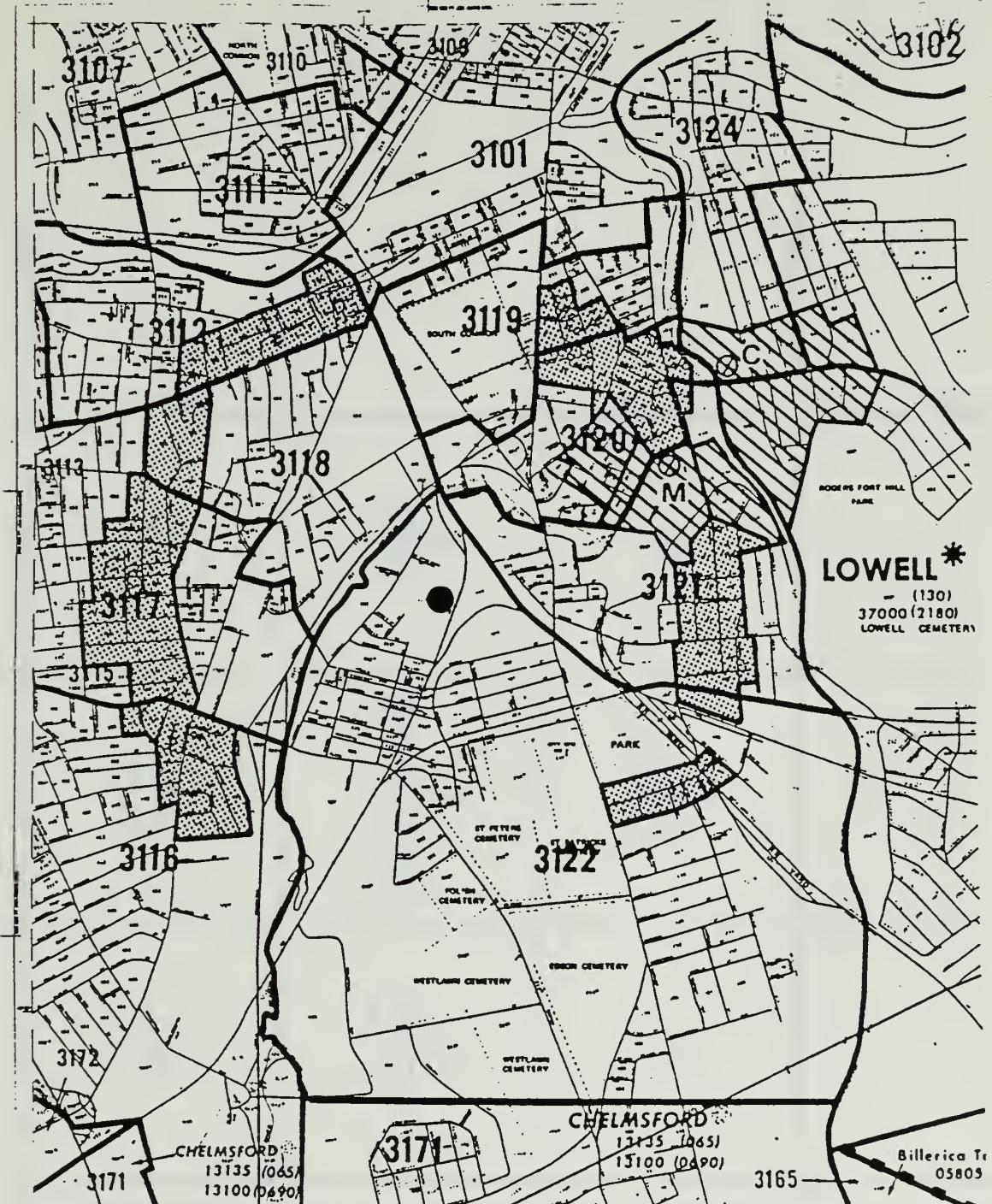
A number of background characteristics of the population also influence the prevalence of symptoms independently of any effect of the emissions. Special efforts were made to collect information on these potential "confounding" variables. They are also given in Table 2-1 and Appendix 2.

Statistical Methods

Populations with and without particular health outcomes were compared for mean exposure levels using a standard t-test. This procedure assumes that each respondent constitutes an independent response. Since data were collected on a household basis, and some correlation between responses from the same household may exist, this procedure may exaggerate significance levels. To account for this sampling procedure, weighted t-tests were also performed treating the household as a unit of analysis.

Multiple logistic regression was then used to assess the effect of exposure after adjusting for the background factors of age, sex, ethnicity, marital status, education, smoking and drinking habits, occupational exposure, interview wave (early or late), language in which interview was conducted, and estimated exposure to emissions. Age and exposure were represented as measurement variables, while all other factors were represented as dichotomous variables. The strength of association with exposure is measured through the odds ratio, given as the ratio of the odds of experiencing a health outcome when exposed at a "high" level (90th percentile exposure) to that of a "low" level (10th percentile exposure). Thus, an odds ratio of 1.4 means that the odds of having a condition are 40% higher at the high level of exposure compared to the low level. Multiple linear regressions were also used to analyze birth weight.

Power Considerations



● Location of Silresim

■ Feb - Mar 1983 Survey

▨ June - July 1983 Survey

M, C Factories

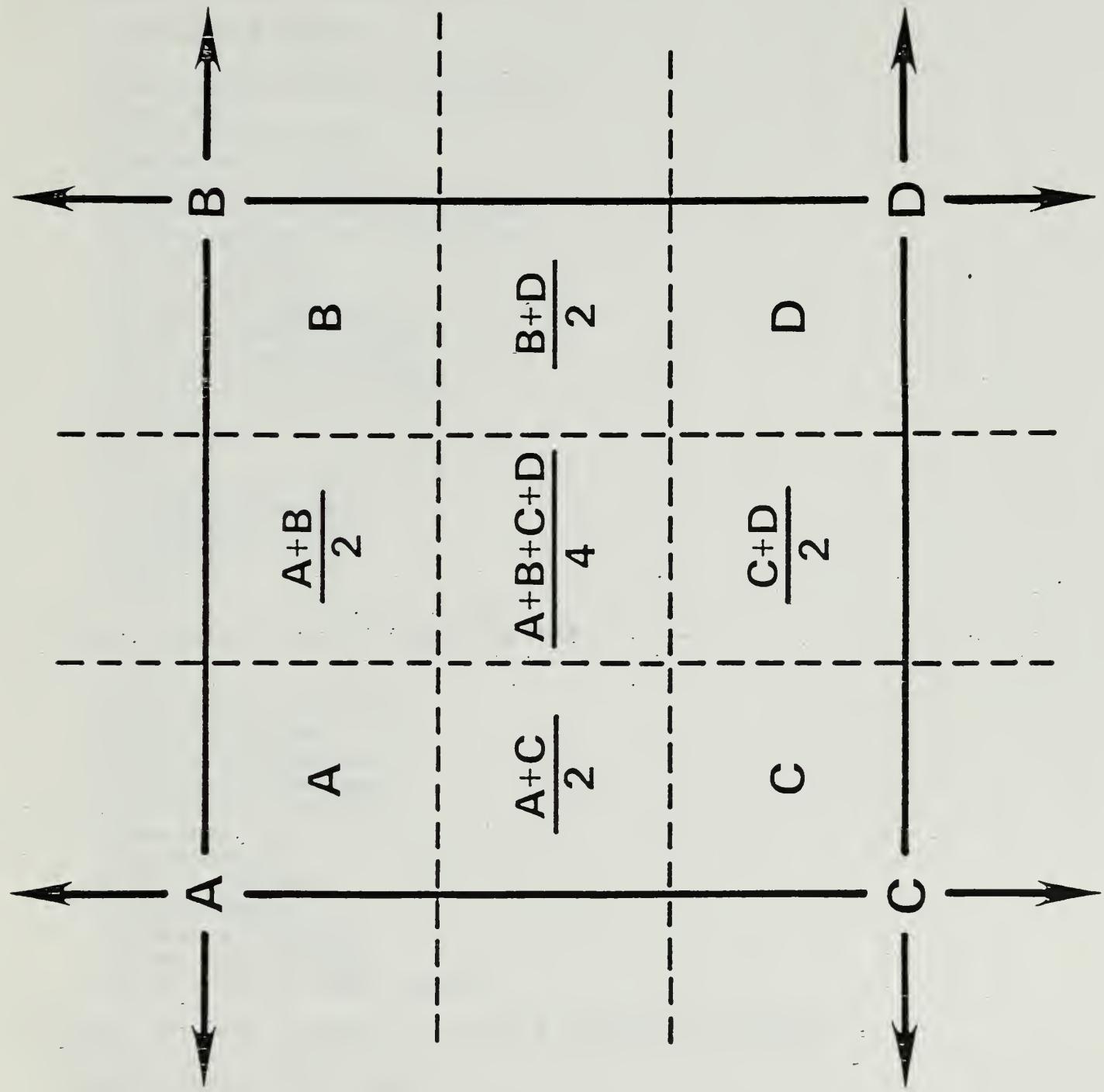


Table 2-1

Adult Health Variables

Comparative and Overall Health

In the past 6 months:

wheezing/tightness in the chest
chest pain
nausea or vomiting
dizziness
shortness of breath
numbness of fingers and toes
unconsciousness or blackouts
swollen glands
skin irritation
irritation eyes/nose
cough, 2 weeks or more
irregular heart beat
loss 10 lbs. w/o dieting
fatigue
nervousness
acne
unusual color urine
bruising/bleeding
persistent colds
headaches
other

Has a doctor ever told you you had:

anemia
other blood problems
kidney problems
respiratory problems
neurologic problems
skin disease/allergy
diabetes
hypertension
high cholesterol
liver disease
digestive disease
cancer (what kind?)
heart trouble (what kind?)

Have you seen a doctor in past 2 months (for what?)

Hospitalized since June?

Miscellaneous

Pet deaths and illnesses

Awareness and attitude towards neighborhood environment:

air and water

Table 2-1 (cont.d)

Reproductive History (women only)

Miscarriage
Stillbirths
Infant and childhood mortality
Prematurity
Birth weight

Child Health Variables

History of:

epilepsy
asthma
bronchitis, more than 3x/yr.
not developing normally
dyslexia
hyperactivity
mental retardation
hearing loss, speech impediment
"slow"
other
earaches
sore throats
frequent colds

Uncommon childhood illness of:

bone
lungs
skin
glands
other

School absences

Condition that limits normal activity

Confounding Variables

Age
Sex
Race/Ethnicity
Marital Status
Income
Housing
Education
Smoking History
Alcohol Use
Occupational/Avocational Exposures

Section 3
Survey Data Collection Procedures

From June 17 through August 3, 1983, the Center for Survey Research conducted 301 interviews in Lowell to complete a study of the health of residents of Lowell living near the Majilite and Compo plants.

948 residents of the designated geographical area were interviewed earlier in the year as part of the comparison group for the Silresim study. Attempts were made to interview every person over 18 within every randomly selected household. Each individual interviewed was asked about his or her own health, residential and occupational history, opinions about contaminants in the air and water, and demographics. Within each household, the first individual interviewed was queried about the dwelling unit, pets, and household practices concerning water use. One adult in the household provided the data on all the children under 18 residing in the household. If the first adult interviewed felt unable to provide the information, it was obtained from an adult who felt qualified to do so.

In this section we describe the sampling procedures, sample sites, response rate, and quality control procedures.

Study Area and Sample

The study area is shown in Figure 2. A circle of radius 1/4 mile was drawn from a point (x) falling midway between the Majilite (M) and Compo (C) plants, which are 1/4 mile apart. An additional quadrant was taken extending from a point 1/4 mile due north to 1/4 mile due west of Compo to account for prevailing wind direction.

The sample frame was drawn in the field. Field personnel were given lists of addresses on each block in the area, which were taken from the city directory. The lister then went to his/her assigned area and made additions or deletions according to what actually existed at the time. Later, during interviewing, "found households" were added to the sample frame. Found households are households uncovered by field personnel by systematic questioning which were not included in the original listing because they do not appear as separate dwellings. An "in-law apartment" without a separate address, mailbox, or phone is an example of a household which might fall into this category. The sample was drawn at the rate of one in four households from 796 households in the designated area for this study. This area does not overlap with the Silresim study control population area. The area for this data collection is in census tracts 3120, 3121, 3123, 3124, and 3125.

Response Rates

While the sample frame for this study was households, the goal in the study was to interview every adult in the sample. Thus, the individual response rate calculated is based on the number of eligible adults in the designated households. For some

households, it was not possible to contact anyone in the household or an interviewed member refused to provide information about the number of adults in the household. Thus, it was necessary to estimate the number of adults in each of those households (all of whom were not interviewed and are thus counted as non-respondents). For the estimate of number of adults in the household, the mean number of adults in households in the sample was used. Thus, for every household for which there was no contact or a refusal without obtaining information about the number of adults, the number of non-respondents was estimated to be 2.03, which was the average number of adults in households for which the number of adults was ascertained.

Table 3-1 shows the calculated response rate for individuals based on these estimates. Line 1 is the total sample from lists, plus "found" households. Line 2 is the households from the listing which were established by interviewers to be non-dwelling units or were vacant. Line 3, then, is the resulting sample frame. Line 4 is the households for which we were unable to ascertain the number of adults. Line 5 is all of the households for which we were able to obtain information on the number of adults, even if it was impossible to obtain an interview with any or all of them. Line 6 is the total number of adults in those households. This number is the one used to estimate the number of adults. This estimate, times the households with unknown adults (line 9), yields the number of estimated adults in the sample. Adding this to the known adults in the sample (lines 6 and 9) gives the estimate of the total eligible adults in line 10. The total eligibles divided into the total interviews yields the response rates shown in line 12. The response rate was 79.4%.

Letter About the Study

A letter was sent to each sampled household explaining the study and telling them to expect to hear from an interviewer. Also included was a fact sheet about the study. For households later identified as Portuguese, a Portuguese letter was delivered by the Portuguese interviewer. When a refusal was received from a household, a follow-up letter was sent before another attempt to obtain an interview was made (see Appendix 3).

Special Procedures for Phone and Field

Because telephone interviewing is considerably less costly, attempts were made to do as much interviewing over the phone as possible. Since the sample frame consisted of addresses, procedures were followed to obtain phone numbers for the households when possible. This resulted in a combination of phone and in-person interviews, which is acceptable survey research practice if the same interview is used for both, as it was in this study.

Attempts were made to obtain a phone number for each of the addresses in the sample through town lists and directory

assistance. "Coversheets" were then prepared for each household in the sample frame. It included contact information and was kept separate from the interview. All coversheets for which we could obtain a phone number were initially assigned to phone interviewers. Those for which we were unable to obtain a phone number were assigned to the field.

For each coversheet assigned to the field, the interviewer went to the household. If contact was made, the interviewer was instructed to take interviews with all adults present at the time and to get a phone number in order to contact by phone any adults who were not interviewed in person. Interviewers made a maximum of 12 visits to a household, well spread over time, before designating a household as a "no-contact."

For coversheets which were initially assigned to the phone, five well-spread calls (varying time of day and including both weekdays and weekends) were made. If no contact was made after five calls, the phone number was verified with the telephone company. If the phone number was incorrect or not working, the coversheet was assigned to the field and procedures followed as if it originated in the field. If the phone number was correct, five additional well-spread phone calls were made before assigning the coversheet to the field. For all phone interviews, the interviewer first verified that he or she had in fact reached a phone number at the correct address. To reach subsequent adults in the household, up to twenty additional calls were made.

Coversheets also moved from the phone to the field for Portuguese respondents who needed to be interviewed in Portuguese.

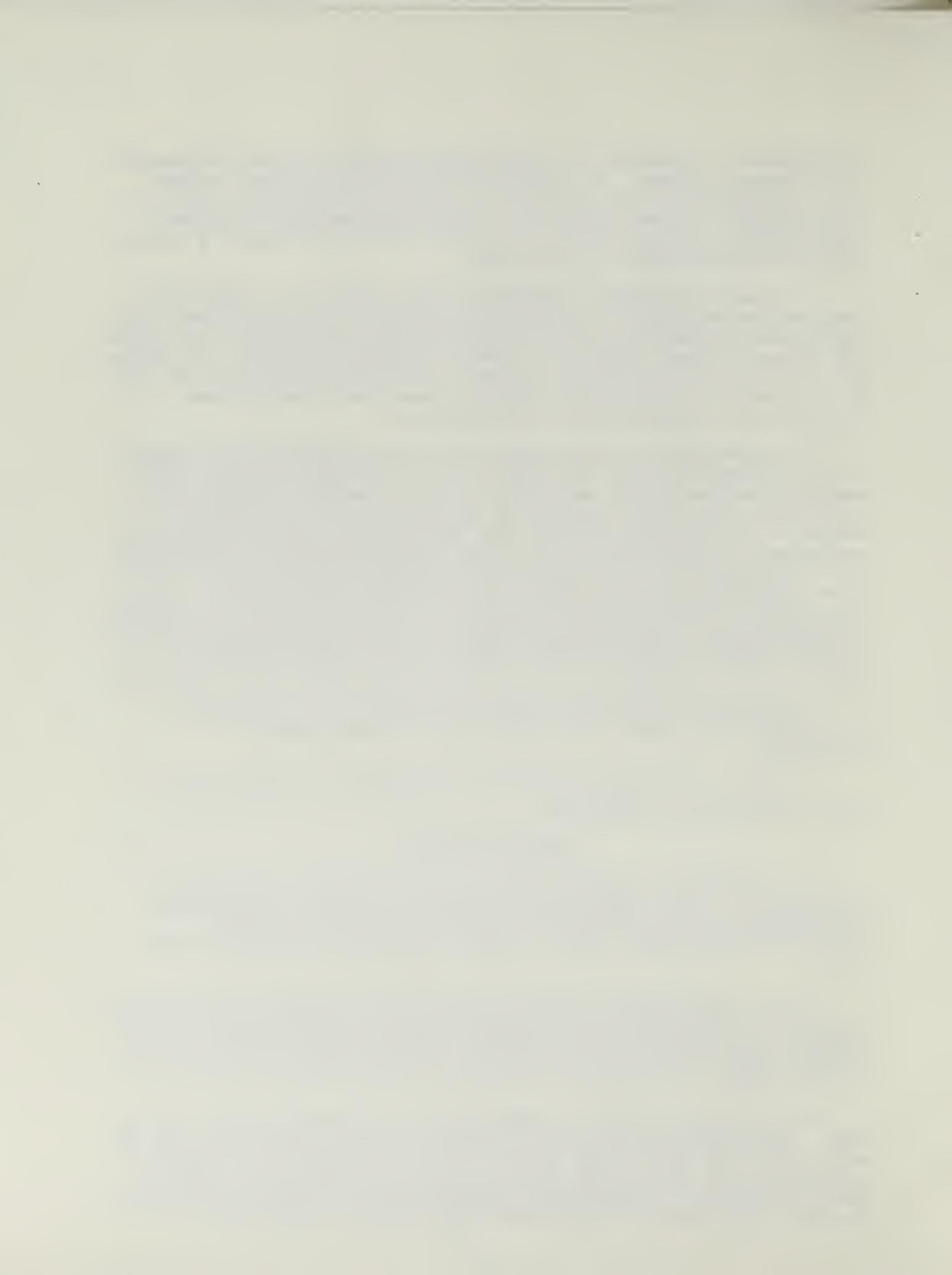
A total of 229 interviews were conducted in-person and 72 were conducted by telephone.

Quality Control

All Center for Survey Research interviewers received a minimum of 3-5 days training in general interview techniques. Additionally, all interviewers who worked on this study, including experienced ones, received one-day training on this study.

Field interviewers worked at least one six-hour shift on the telephone so that their interviewing could be monitored. Their completed interviews were reviewed as they were returned to the office. Each field interviewer had at least weekly contact with a supervisor.

During phone shifts, a supervisor was always present in the room. At least one interview was monitored by the supervisor for each shift the interviewer worked, and two additional completed interviews per interviewer were carefully reviewed each shift. Specific areas of interviewing technique were rated and immediate feedback was given to each interviewer by the supervisor.



Additionally, every "non-interview" and "first refusal" was reviewed by the supervisor.

Approximately 20% of the sample was recontacted to ensure that they were in fact interviewed.

Portuguese Interviews

Lowell has a substantial number of Portuguese residents. In cases where the respondent was not fluent in English, the interview and respondent letter were translated into Portuguese and interviews were conducted in Portuguese by three Portuguese interviewers. 107 interviews were conducted in Portuguese.

Table 3-1
Lowell II Field Results

1. Household Sample	199
2. Non-samples (not dwelling or vacant)	12
3. Total Eligible Households	187
4. Households - # Adults Not Ascertained	8
Refusal	(5)
Limit	(3)
5. Households - # Adults Known	179
6. # Known Adults in Household	363
7. Average # Adults in Household	2.03
8. # Known Adults in Household	363
9. Average x Non-interviewed Households	16
10. Total Eligible Sample	379
11. Interviews Taken	301
12. Response Rate	79.4%



Section 4
Description of the Study Populations

In this section we summarize sociodemographic and behavioral characteristics of the study population. The total sample consisted of 1,043 adults (in 681 households), of which 680 were interviewed in February-April of 1983 and 363 were interviewed from June to August, 1983.

A correlation coefficient of exposure and age did not reveal a significant correlation (Table 4-1). Mean exposure levels were compared for other sociodemographic and behavioral/occupational subgroups of the study population using analysis of variance tests (Tables 4-2 and 4-3). Nor were there significant exposure differences for members of the study population by sex, employment status, income, current smoking or number of daily alcoholic drinks. Mean exposures of most occupational subgroups were similar except for those exposed to smoke, fumes and vapors and those exposed to lead. In each case, the occupationally exposed groups had lower mean exposures to the emissions from the two neighborhood facilities.

The most striking association with exposure was the language in which the interview was conducted. Portuguese speaking adults, constituting 15% of the sample, had a mean exposure level twice that of the rest of the sample, reflecting a geographic concentration in one particular area. Separated and divorced had somewhat lower exposures, as did those who identified themselves as non-whites or Hispanics, compared to whites. Those with 8th grade education or less and a small number of college graduates had higher mean exposures. While there were some differences according to number of adults in the household, these differences were not large. Multi-unit houses were also in areas of higher exposure.

There were also some differences in exposures according to whether a person had smoked, with lifelong non-smokers having higher exposures; and those who drank most frequently also had higher mean exposures.

The overall picture, then, shows higher mean exposures for Portuguese speaking residents, frequent drinkers, non-smokers, currently married adults, and those occupying multi-unit dwellings. Those who reported workplace exposures to either smoke, fumes or vapors, or lead also had lower mean exposures to the factory emissions. Since some of the differences in mean exposure involve factors that could also be related to health outcomes, the need for statistical control of these potential confounders in the analysis was suggested. The results of both univariate and multivariate analyses will be found in the following sections.

Table 4-1

Description of Study Population
Age and Exposure

Adults, ages 18+:

correlation coefficient for age and exposure = .03997,

p = .1990
n = 1043

Children, ages 0-17:

correlation coefficient = -.011,

p = .77
n = 619

Table 4-2
Description of Study Population
Demographic Variables

	N	Mean Exposure	p*
Sex			ns
Males	482	49.28	
Females	561	54.02	
Marital Status			.0196
Married	592	56.22	
Widowed	81	56.64	
Separated	39	31.47	
Divorced	65	39.84	
Never Married	263	46.51	
Ethnicity			.0317
White	959	53.69	
Black	14	28.52	
Hispanic	53	30.78	
American Indian	4	37.71	
Asian	13	29.44	
Education			.0001
8th grade or less	277	73.08	
1-3 yrs high school	239	41.30	
high school graduate	331	41.49	
1-3 yrs college	120	45.25	
college graduate	54	74.13	
graduate education	17	31.29	
Family Income			ns
- 5,000	73	41.86	
5,000-10,000	182	47.19	
10,000-15,000	212	46.85	
15,000-20,000	117	52.65	
20,000-25,000	155	54.40	
25,000-30,000	86	41.80	
30,000+	85	56.07	
Language			.0001
English	811	45.67	
Portuguese	153	86.16	
Spanish	26	31.09	
Other	3	61.52	
Currently Working			ns
Yes	629	53.61	
No	414	49.10	

	N	Mean Exposure	p*
Unemployment			ns
unemployed	56	42.33	
laid-off	50	49.35	
retired	111	53.77	
medical leave	10	31.88	
disabled	45	64.44	
homemaker	118	39.92	
student	14	43.23	
Number of adults in house			.0439
1	165	44.46	
2	516	53.21	
3	229	50.53	
4	87	68.03	
5	42	41.04	
6	4	10.41	
Number of units in house			.0001
single family house	936	46.50	
2 or 3 family house	90	103.95	
more than 3 units	17	68.98	

*One-way analysis of variance; ns means p .05.

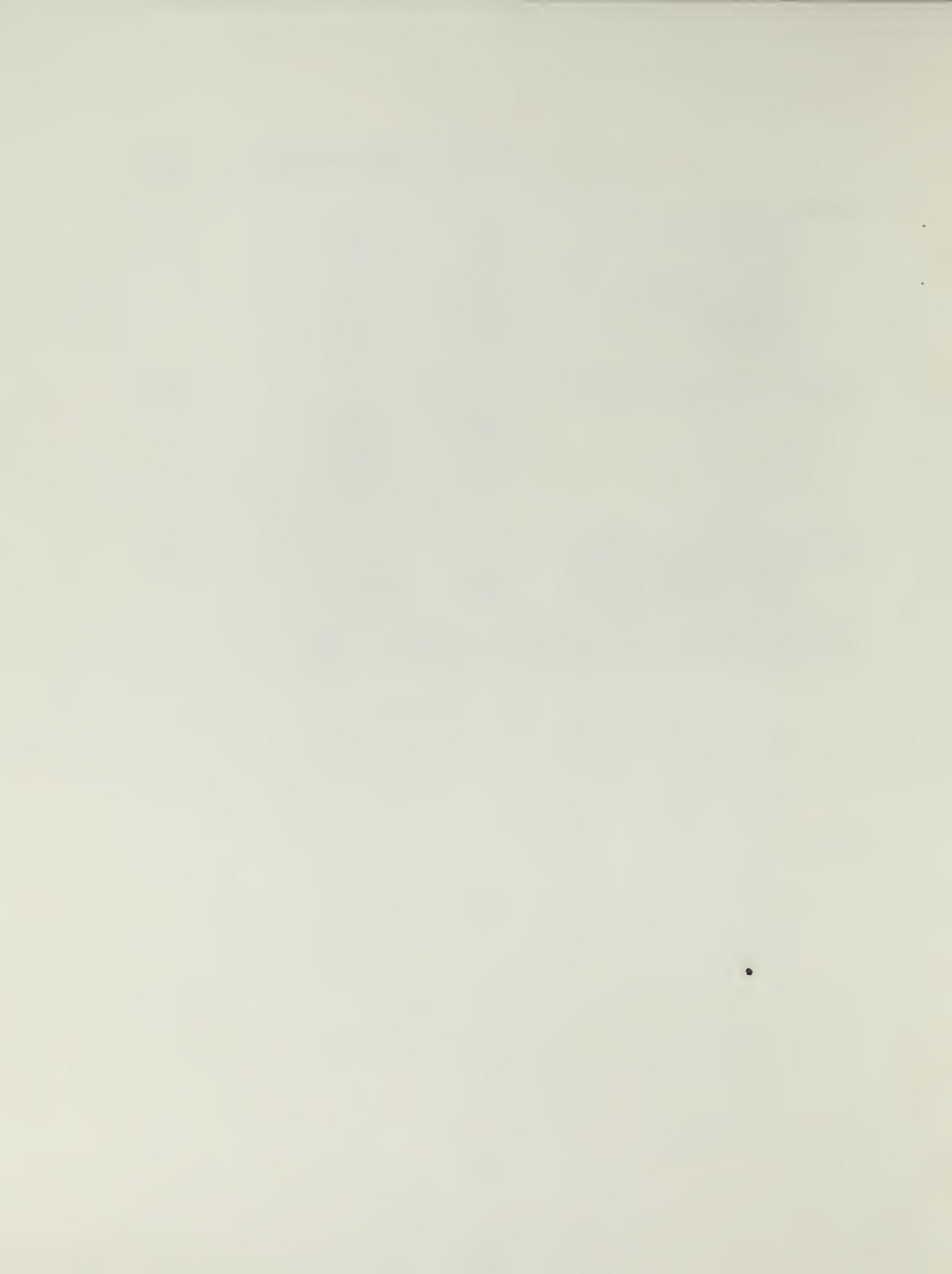


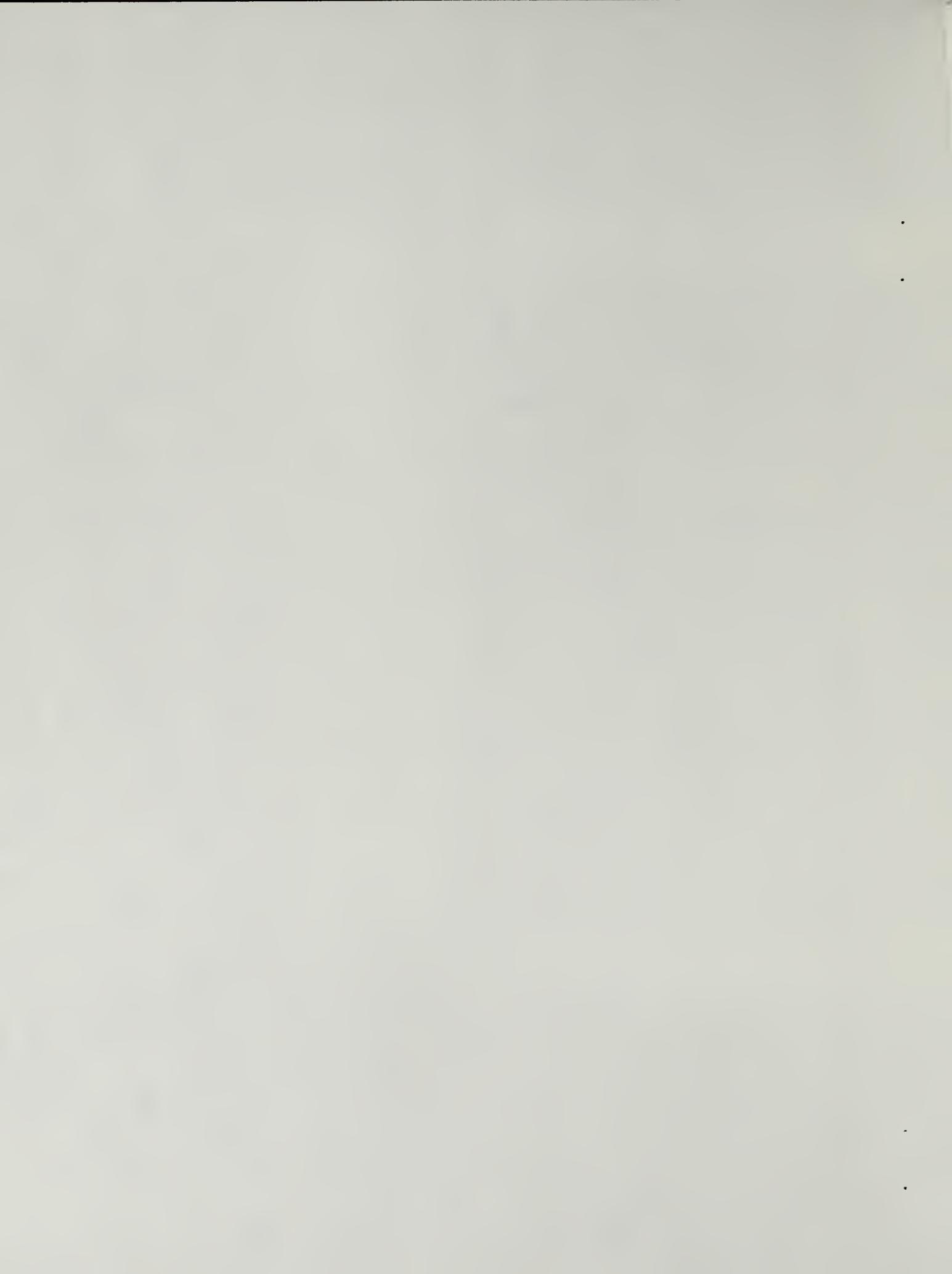
Table 4-3

Smoking, Drinking and Occupational Exposures

	N	Mean Exposure	p*
Current smoker			ns
yes	413	47.19	
no	180	43.86	
Ever smoker			.0008
yes	595	46.16	
no	448	59.35	
Drinking frequency/mo.			.0001
non-drinkers	337	50.00	
1-5/mo.	309	46.27	
6-10/mo.	114	42.62	
11-20/mo.	89	48.74	
21+/mo.	187	71.62	
Number of daily drinks			ns
0	334	49.98	
1-2	338	57.68	
3-6	269	46.51	
7+	91	54.78	
Occupational Exposures:			
Ever exposed to			
Smoke, fumes, vapors			.0026
yes	375	43.85	
no	617	56.32	
Pesticides or herbicides			ns
yes	47	41.72	
no	935	52.06	
Irritants to eyes or nose			ns
yes	236	52.55	
no	760	51.57	
Asbestos			ns
yes	75	41.62	
no	886	52.73	
Beryllium			ns
yes	6	28.28	
no	910	51.14	
Radiation			ns
yes	44	52.83	
no	893	49.90	

	N	Mean Exposure	p*
Sandblasting, silica, rockcrushing, rockdrilling, talc			ns
yes	93	55.40	
no	895	64.37	
Solvents/degreasers, such as perc or trichlor			ns
yes	177	48.47	
no	796	52.67	
Lead			.0550
yes	57	35.82	
no	924	52.23	
Mercury, Cadmium, Arsenic			ns
yes	25	35.32	
no	941	52.48	

*One-way analysis of variance; ns, p .05.



Section 5
Findings: Adults

Univariate Comparisons

Table 5-1 compares mean exposure levels for those with and without self-reported symptoms within the previous 6 months, and also compares those with and without disease conditions about which the respondent was told by his/her doctor or other health care provider. A t-test was used to estimate the role played by chance in any differences. The data was analyzed separately for WAVE 1 (February-April), WAVE 2 (June-August) and total (WAVE 1 and WAVE 2) data sets, because there were differences in emissions during the two periods (see Section 2), as well as seasonality differences (winter versus summer).

Table 5-1 summarizes the significant differences for these three data sets. Mean exposures to the factory emissions were significantly higher for those reporting eye and nose irritation in both the entire sample and WAVE 1 respondents, as well as for kidney problems (told by doctor) in WAVE 1. By contrast, no conditions had significantly higher mean exposures on WAVE 2. A variety of complaints had lower exposures on all three data sets (see Table 5-1). Most of these negative associations disappeared after adjusting for confounding (see below). Analyses accounting for within household correlation (weighted t-tests) are presented in Table 5-2.

Control of Potential Confounding by Multivariate Analysis

Using the technique of multiple logistic regression, we controlled for the following characteristics of the population: sex, age, marital status, ethnicity, education, number of daily drinks, current and former smoking, language of respondent, interview WAVE and exposure estimate for the household. WAVE can be taken as a surrogate for season (WAVE 1 = winter, WAVE 2 = summer). Odds ratios were calculated over an exposure span comprising values in the 10th percentile versus the 90th percentile, a range of 118 exposure units. Because of lower exposures in WAVE 1, odds ratios were calculated comparing exposure 23 with exposure 73 for those respondents when considered separately. Separate regressions were done for WAVE 1, WAVE 2 and the total (WAVE 1 and WAVE 2). For the total sample, WAVE was used as a regression variable.

Tables 5-3, 5-4, 5-5, and 5-6 present the results. After adjusting for possible confounders, WAVE 1 (winter interview) subjects showed exposure-associated symptoms and medical histories associated with eye and nose irritation, nausea and/or vomiting, diarrhea and constipation, colored urine, history of kidney problems, dizziness, and recent visit to a doctor. Both diarrhea/constipation (borderline at $p = .06$) and kidney problems are associated with exposure in WAVE 2 (summer) respondents as well. When the whole sample is considered, diarrhea/constipation and kidney problems are still associated with exposure, as is wheezing and tightness in the chest. The failure of the latter variable to attain significance in either of WAVE 1 or WAVE 2 (the two component parts of the total sample) is undoubtedly a

G. HOUSEHOLD INFORMATION

G1a. INTERVIEWER CHECK (FROM COVERSHEET, COLUMN G)

HAS THE HOUSEHOLD DATA BEEN GIVEN BY ANOTHER ADULT? (i.e. IS THERE A IN COLUMN G?)

1 [] YES (SKIP TO PAGE 29, H1)

9:60

2 [] NO (ENTER CHECK IN COLUMN G AND GO TO G2)

CODER: K1-K3 :61-63

DUPLICATE :1-13

0 1 :14-15

G2. [ASK IF PHONE; FILL OUT BY OBSERVATION IF IN PERSON] Do you live in a single family house, a two or three family home, an apartment or flat, a mobile home, or what?

1 [] HOUSE

2 [] TWO OR THREE FAMILY HOME

3 [] APARTMENT OR FLAT (4 OR MORE UNITS IN BUILDING) :16

4 [] MOBILE HOME

[] OTHER: (SPECIFY) _____

G3. Do [you/members of your household] drink only tap water, only water you buy or bring home in bottles, or both tap water and other water?

1 [] ONLY TAP WATER (SKIP TO G4)

:18

2 [] ONLY OTHER WATER YOU BUY OR BRING HOME

:19

3 [] BOTH TAP WATER AND OTHER WATER

G3a. Why do you not just drink tap water?

G4. Since living in your present home, have you had any dogs?

1 [] YES

10:20

2 [] NO (SKIP TO H1)

G5. Have you had any dogs die since living there?

1 [] YES

:21

2 [] NO (SKIP TO H1)

G5a. How many?

:22

_____ NUMBER

G6. Did [any of them/your dog] die of an illness, other than old age or an accident?

1 [] YES

:23

2 [] NO (SKIP TO H1)

G7. What kind of illness/illnesses? [IF MORE THAN 3, RECORD 3 MOST RECENT]

1. _____

2. _____

3. _____

G8a. 1. When did that occur?

_____ YEAR

2. When did that occur?

_____ YEAR

3. When did that occur?

_____ YEAR

24-32: _____

Table 5-1 (cont'd.)

WAVE 2 Subjects Only

Outcome	*	N	Mean Exposure	p-value**
Shortness of breath	+	38	106.53	.05
	-	254	127.12	
Irregular heartbeat	+	34	103.94	.02
	-	257	127.58	
Colored urine	+	10	94.56	.04
	-	282	125.71	
Digestive problems	+	57	106.20	.008
	-	236	128.82	
Headaches	+	30	103.23	.03
	-	263	126.84	
Cancer	+	12	91.80	.02
	-	281	125.81	

* + = symptom reported

- = symptom not reported

**t-test, two-tailed

Table 5-3
 Association with Exposure
 Multiple Logistic Regression
 WAVE 1 Subjects Only (N=680)

	Coefficient of exposure variable (standard error, s.e.)	p	Adjusted* Odds Ratio
Nausea, vomiting	.013 (.005)	.01	1.9
Diarrhea, constipation	.011 (.004)	.01	1.7
Eyes, nose irritation	.010 (.005)	.04	1.6
Colored urine	.017 (.007)	.02	2.4
Kidney problems	.015 (.006)	.01	2.1
Dizziness	.010 (.005)	.03	1.7
Seen doctor	.009 (.004)	.04	1.6

*Extremes of exposure variable 7, 89. Odds ratio based on comparing exposure = 73 with exposure = 23 (90th and 10th percentiles for WAVE 1 sample).

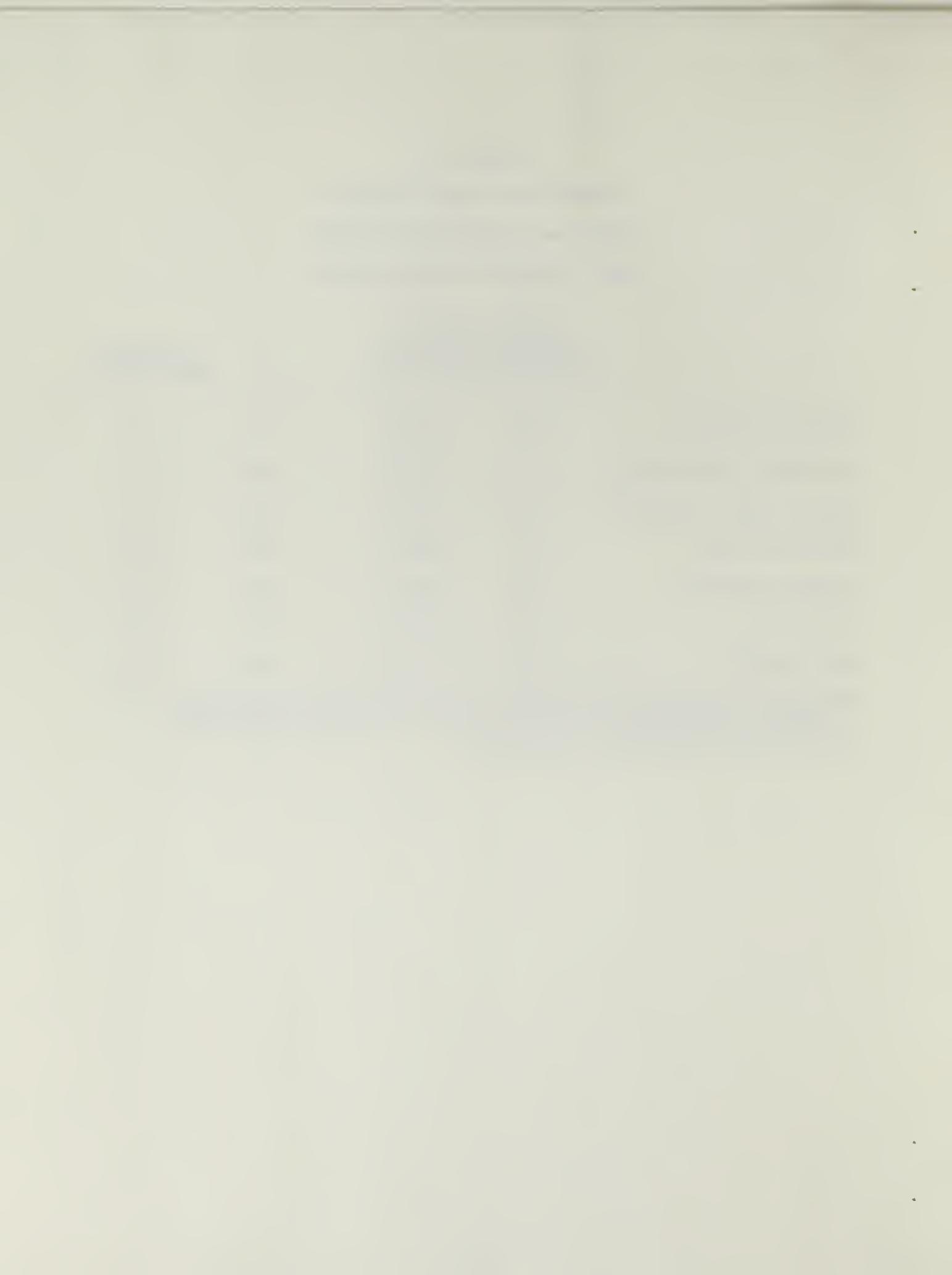


Table 5-4
 Association with Exposure
 Multiple Logistic Regression
 WAVE 2 Subjects Only (N=363)

	Coefficient of exposure variable (standard error, s.e.)	p	Adjusted* Odds Ratio
Diarrhea, constipation	.004	(.002)	.06
Kidney problems	.006	(.003)	.05

*Extremes of exposure variable 7, 363. Odds ratio based on comparing exposure = 127 with exposure = 9.

Table 5-5
 Association with Exposure
 Multiple Logistic Regression
 Entire Sample (N=1043)

	Coefficient of exposure variable (standard error, s.e.)	p	Adjusted* Odds Ratio
Diarrhea, constipation	.004	(.001)	.01
Kidney problems	.006	(.002)	.01
Wheezing, tight chest	.004	(.002)	.04

*Extremes of exposure variable 7,363. Odds ratio based on comparing exposure = 127 with exposure = 9.

Table 5-6
 Association with WAVE*
 Multiple Logistic Regression
 Entire Sample (N=1043)

	Coefficient of WAVE Variable** (standard error, s.e.)		p	Adjusted*** Odds Ratio
Cough	.533	(.217)	.01	1.7
Shortness of breath	.769	(.209)	.0002	2.2
Chest pains	.542	(.222)	.01	1.7
Anemia	-.512	(.214)	.02	0.58
Acne	1.106	(.395)	.005	3.0
Fatigued, tired	.506	(.167)	.003	1.6
Dizziness	.443	(.212)	.04	1.6
Nervousness	.716	(.173)	.0001	2.0

*Ethnicity not included in regression.

**A negative coefficient for this variable indicates a higher prevalence in the WAVE 2 sample as compared to the control.

***Based on comparing exposure = 127 with exposure = 9.

Table 5-7

Summary of Relationships of Health Outcome Variables
to Exposure and Season (Tables 5-3 to 5-6)

Associated with exposure in both seasons (Tables 5-3 to 5-6):

Diarrhea/constipation
History of kidney problems
Wheezing/tight chest (significant in entire sample, positive coefficient in both sub-samples)

Associated with exposure in winter only and unrelated to season (Tables 5-3 and 5-6):

Eyes, nose irritation
Nausea/vomiting
Colored urine
Recent visit to doctor

Associated with season only (data not shown):

Acne
Nervousness
Anemia
Swollen glands

Associated with season only when exposure not also a variable (data not shown):

Unusual fatigue/tiredness
Dizziness
Shortness of breath
Persistent cough
Chest pains

Section 6
Findings: Child Health

Univariate Comparisons

Tables 6-1 and 6-2 show the mean exposures for children in respondents' households with and without various acute and chronic conditions. The information was supplied by the most knowledgeable adult, usually the mother. Questions concerned childhood illnesses and conditions and were not the same as the adult questions (see Appendix 2).

The only significant differences in mean exposure were for two children who were reported to be unable to attend school regularly (Table 6-2). Although the differences in mean exposure values between these two children and others was highly significant, the small number leaves the meaning of this result open to question.

Control of Confounders

Multiple logistic regression was used to control for a variety of background variables as in the adult analysis. The control variables were marital status of the mother (currently married or not), mother's education, mother's workplace exposure, current smoker in house (yes/no), type of house, number of persons in the family, sex of child, age of child, language of interview, ethnicity, drinking habits of mother, for the acute conditions of pre-school children whether they attended group day care or not, and season (WAVE 1/WAVE 2).

After adjustment for confounding, a history of frequent earaches (more than 2x/2months) was associated with exposure in pre-school children (Table 6-3) when the whole sample was considered. The odds ratio was 9.30. When the winter (WAVE 1) subjects were looked at separately, the association was still positive but failed to reach significance ($p = .09$), a reflection of reduced sample size. School-age children actually showed a significant negative association of earaches with exposure in the winter interviews (Table 6-4), although when the entire sample was considered, the association was positive and not significant. There is no obvious explanation for this in terms of the hypothesis being tested. Earaches were also more prevalent in the winter in the pre-school population, although the winter-summer variable was of borderline statistical significance ($p =$ seasonal effect was not present).

For the sample taken as a whole (both seasons combined), there were no other significant associations with exposure. However, among school-age children, frequent colds in the winter-time were associated with exposure (Table 6-4). None of the chronic conditions were significantly associated with exposure after controlling for confounding.

Thus, the only child health outcomes associated with the factory emissions were more frequent earaches in pre-school children and more frequent winter-time colds in school-age children.

Table 6-1
Acute Outcomes: Univariate Comparisons

		N	Mean Exposure	p-value*
<hr/>				
Children 0-5 yrs.				
Earaches, 2x/2mos.	+	20	65.17	ns
	-	215	41.08	
Sore throats, 2x/2mos.	+	17	39.16	ns
	-	218	43.44	
Frequent colds past year	+	73	38.78	ns
	-	162	45.09	
Children, 6-17 yrs.				
Earaches, 2x/2mos.	+	20	46.05	ns
	-	394	46.14	
Sore throats, 2x/2mos.	+	54	39.77	ns
	-	360	47.09	
Frequent colds past year	+	78	52.12	ns
	-	334	44.53	

*Weighted t-test, two-tailed

Table 6-2

Chronic Diseases and Conditions: Univariate Comparisons

		N	Mean Exposure	p-value*
Epilepsy	+	7	42.74	ns
	-	611	46.16	
Asthma	+	39	45.66	ns
	-	579	46.18	
Bronchitis, 3x in 1 yr.	+	31	43.46	ns
	-	580	46.51	
Developmental disorders	+	58	40.35	ns
	-	554	47.01	
Diagnosed as having bone, blood, lung, skin, - glandular or other problems that are not common childhood diseases	+	46	47.30	ns
	-	556	45.67	
Birth defect	+	22	51.25	ns
	-	595	45.91	
Ability to go to school regularly	+	2	159.18	.0001
	-	614	45.81	
Condition which limits activity	+	10	35.98	ns
	-	603	46.22	

*Weighted t-test, two-tailed

Table 6-3

Multiple Logistic Regression - Child Health
Association with Exposure

Acute Outcome	Coeff. of Exp. Variable	(s.e.)	p-value	adjusted odds ratio*
<hr/>				
Children, 0-5 yrs.				
earaches	.0189	.006	.0025	9.30
sore throat	.0066	.012	ns	
frequent colds	.0039	.004	ns	
Children, 6-17 yrs.				
earaches	.0019	.0067	ns	
sore throat	.0046	.0047	ns	
frequent colds	.0035	.0035	ns	
<u>Chronic Conditions</u>				
Children, 0-17 yrs.				
epilepsy	-.0080	.0138	ns	
asthma	.0041	.0049	ns	
bronchitis	.0031	.0058	ns	
developmental disorders	-.0059	.0049	ns	
bone, blood, etc.	.0004	.0042	ns	
birth defect	.0016	.0056	ns	
condition limiting activity	-.0146	.0134	ns	

*Odds ratio based on comparing exposure = 127 to exposure = 9.

Table 6-4

Multiple Logistic Regression - Child Health
Association with Exposure

WAVE 1 (winter) Subjects Only

Acute Outcome	Coeff. of Exp. Variable	(s.e.)	p-value	adjusted odds ratio*
<hr/>				
Children, 0-5 yrs.				
earaches	.0253	(.0150)	.09	
sore throats	.0066	(.0213)	.75	
frequent colds	.0157	(.0101)	.11	
Children, 6-17 yrs.				
earaches	-.0964	(.0447)	.03	.09
sore throats	.0034	(.0108)	.74	
frequent colds	.0207	(.0089)	.02	1.65

WAVE 2 (summer) Subjects Only

Children, 0-5 yrs.	sample size too small for multiple regression
earaches	
sore throats	
frequent colds	
<hr/>	
Children, 6-17 yrs.	
earaches	.0042
sore throats	.0133
frequent colds	.0011

*Odds ratio compares exposure = 23 to exposure = 73.

Section 7

Findings: Reproductive Outcome

A variety of reproductive outcomes with possible relationship to the factory emissions were examined. These included a history of ever being pregnant; history of hysterectomy; history of spontaneous abortion ("miscarriage"); history of stillbirth; history of low birthweight child; history of menopause; and history of premature infant.

The univariate analyses (Tables 7-1 to 7-4) show a borderline higher mean exposure level for those women reporting that they were never pregnant ($p = .06$) (Table 7-1). For those women who did become pregnant, those who reported they gave birth to at least one premature infant had significantly lower mean exposure levels, running counter to the hypothesis. When the two interview samples were looked at separately (Tables 7-2 and 7-3), analysis showed that women with hysterectomies in the high exposure area (WAVE 2 sample) had higher mean exposures than those who did not. Of women who were pregnant, there is a persistent tendency to have higher mean exposure levels for women reporting miscarriages and stillbirths in the high exposure area, although the small sample sizes do not allow these differences to reach statistical significance. There is no apparent relationship between exposure and low birthweight (less than 2500gm), or with exposure and birthweight considered as a continuous variable (Table 7-4).

The same reproductive outcomes were analyzed with multivariate methods to assess the impact of potential confounders (Tables 7-5 and 7-6). Multiple logistic regression models were used with mother's marital status, education, maternal workplace exposure, maternal smoking (current and former), type of house, number of adults in household, maternal age, sex of infant, drinking habits of mother, ethnicity, language of interview and exposure as variables. Again, those with higher exposures are more likely to have never been pregnant, or if pregnant, to have a miscarriage. No effect on birthweight is discernable.

In summary, there is a suggestion that higher exposures are related to miscarriage or history of no pregnancy, but show no association with prematurity or birthweight.

Table 7-1

Univariate Analysis: Reproductive Outcomes by Exposure
All Respondents

Reproductive Outcome		N	Mean Exposure	p-value*
Of all women				
ever pregnant	+	433	50.6	.06
	-	136	64.9	
had hysterectomy	+	82	60.7	ns
	-	479	52.5	
menopausal	+	144	49.1	ns
	-	339	52.3	
fertility problem	+	44	44.3	ns
	-	512	54.0	
Of women who have been pregnant				
ever miscarriage	+	130	54.9	ns
	-	300	48.9	
ever stillbirth	+	22	62.9	ns
	-	386	48.2	
any premature	+	69	36.2	.01
	-	336	52.1	

*t-test, two-tailed

Table 7-2

Univariate Analysis: Reproductive Outcomes by Exposure
 WAVE 1 (exposure range 7 to 81)

Reproductive Outcome	N	Mean Exposure	p-value*
<hr/>			
Of all women			
ever pregnant	+ 308 - 91	22.9 24.5	ns
had hysterectomy	+ 57 - 337	20.3 23.8	ns
menopausal	+ 103 - 245	24.9 23.3	ns
fertility problem	+ 33 - 358	18.8 23.3	ns
Of women who have been pregnant			
ever miscarriage	+ 91 - 215	22.7 23.1	ns
ever stillbirth	+ 16 - 280	24.3 22.5	ns
any premature	+ 54 - 238	18.7 23.7	ns

*t-test, two-tailed

Table 7-3

Univariate Analysis: Reproductive Outcomes by Exposure
 WAVE 2 (exposure range 31 to 363)

Reproductive Outcome	N	Mean Exposure	p-value*
<hr/>			
Of all women			
ever pregnant	+ 125 - 45	118.8 146.6	.08
had hysterectomy	+ 25 - 142	152.7 120.6	.05
menopausal	+ 41 - 94	109.9 128.1	ns
fertility problem	+ 11 - 154	120.8 125.2	ns
Of women who have been pregnant			
ever miscarriage	+ 39 - 85	130.1 114.2	ns
ever stillbirth	+ 6 - 106	165.7 115.9	ns
any premature	+ 15 - 98	99.2 121.0	ns

*t-test, two-tailed

Table 7-4
Univariate Analysis: Birth Outcomes by Exposure
Entire Sample

		N	Mean Exposure	p-value
Low birthweight (less than 2500gm)	+	53	34.8	ns
	-	541	44.9	
WAVE 1 (exposure range 7 to 89)				
Low birthweight (less than 2500gm)	+	44	20.3	ns
	-	424	24.3	
WAVE 2 (exposure range 31 to 363)				
Low birthweight (less than 2500gm)	+	9	105.6	ns
	-	117	119.6	

Correlation coefficient, exposure and birthweight (continuous variable) = .15, p = .09

Table 7-5

Multiple Logistic Regression - Reproductive Outcomes

Coefficient for exposure (std. error) p-value

Of all women

ever pregnant	-.004 (.002)	.03
had hysterectomy	.002 (.001)	ns
menopausal	-.003 (.003)	ns
fertility problem	.000 (.003)	ns

Of women who have
been pregnant

ever miscarriage	.004 (.002)	.02
ever stillbirth	.003 (.003)	ns
any premature	-.005 (.003)	ns

Table 7-6

Multiple Regressions - Birth Weight

Multiple Logistic Regression: Coeff. (s.e.) p-value

Low birthweight (less than 2500gm)	-.006 (.006)	ns
---------------------------------------	--------------	----

Multiple Regression

Birthweight (continuous variable)	1.84 (.79)	.02
--------------------------------------	------------	-----

Section 8
Discussion

The study findings suggest that there is a positive association between exposure to the factory emissions and a number of health outcomes in adults and children, and some reproductive outcomes. These associations could not be explained by variations in demographic make-up, occupational experiences or lifestyle factors in the exposed population. To put these findings in perspective, they must be viewed in the context of the limitations of this study and in terms of the possible sources of bias.

The most serious difficulty faced in the analysis stemmed from the fact that the health survey was conducted over two periods, five months apart. The second interview sample consisted of residents much closer to the two facilities in question and contained a large Portuguese sub-population. To account for any differences that might be connected with the language in which the interview was conducted, "language" was included as a variable in the logistic regressions. While the past exposures of these residents was high (as reflected in the computer modeling), enforcement and abatement actions undertaken by DEQE in March, April and May resulted in a substantial decrease in actual exposure at the time of the survey. This could have affected responses to questions about acute conditions in adults and children, but should not have affected the reporting of chronic conditions or reproductive outcomes. Furthermore, the effect on the acute symptoms would be to reduce any positive associations with exposure (because of misclassification error), not to introduce any spurious associations.

The time difference between the interview WAVES also introduced a seasonality difference (winter versus summer). Thus, season was correlated with exposure, introducing a serious potential for confounding. Six of the positive associations with exposure in adults (diarrhea/constipation, wheezing and tightness in the chest, history of kidney problems, eye/nose irritation, nausea/vomiting and recent visit to a doctor) and frequent earaches in pre-school children were unaffected by season (see Sections 5 and 6), while five others (shortness of breath, persistent cough, chest pains, fatigue, and dizziness) were so seriously confounded by season as to prevent a determination whether there was an association with exposure.

The gastrointestinal complaints, respiratory problems and eye/nose irritation are consistent with the known effects of these chemicals at levels not too different than found in this community. The history of kidney problems, earaches in pre-schoolers, and association with miscarriage are not generally thought to be typical of exposures to these chemicals (see Appendix 1).

Because the sample size was modest in size, this study could not detect small risk ratios (see "Power Considerations," Section 2). This would tend to make associations more difficult to detect. On the other hand, while a number of statistically

significant associations were found, many comparisons were made and, therefore, some differences due solely to random fluctuations might be expected. To offset this, more conservative two-tailed statistical tests were used in place of one-tailed tests in reporting p-values.

With regard to bias, there are several possible sources. In any interview administered survey, bias introduced by the interviewer must be considered. The quality control measures used have been detailed in Section 3. There is no compelling reason to suggest that there was significant interviewer bias. Likewise, the excellent response rate (79%) does not suggest selection bias as a factor. Recall bias, a serious problem in other studies where knowledge of exposure is a factor, does not seem relevant here where the residents were generally not aware of their exposures at the time of the study. No indications of the purpose of the study were made in the interview itself (see Appendices 2 and 3).

The introduction of spurious associations by correlation of exposure with background (confounding) variables has already been discussed with respect to language and seasonality. Multiple logistic regression was used to control for the other usual confounders of age, race, sex, income/education and smoking, as well as some less usual ones, such as occupational exposures and drinking habits.

Thus, the revealed associations with exposure are unlikely to be a result of systematic bias and are consistent, in part, with known effects of the contaminants involved, but are also present in a setting of multiple comparisons and seasonal confounding. The uncertainty in exposures related to the abatement activities that took place between the two interview WAVES would not have introduced any spurious associations.

Section 9
Conclusions

This study tested the hypothesis that adverse health and reproductive outcomes were associated with exposure to the factory emissions described in Section 1. There was in fact a statistically significant association between this exposure (as represented by a computer model based on stack emission parameters and meteorological conditions) and gastrointestinal complaints (diarrhea/constipation, nausea/vomiting), eye/nose irritation, wheezing/tightness in the chest, history of kidney problems and recent visit to a doctor, for adults; frequent earaches in pre-school children in the winter-time; and never being pregnant or having a miscarriage. A variety of respiratory complaints, fatigue, and dizziness were too confounded with seasonality to be able to judge whether there was an association or not.

The question whether these associations are causal or not can usefully be considered in terms of the criteria of A. Bradford Hill:

Consistency: Many of the reported symptoms (gastrointestinal, mucous membrane irritation, respiratory, kidney disease) are consistent with those reported in occupational settings where DMF, xylene and toluene are used. There is no comparable information on exposures to pre-school children or pregnant/fertile women.

Temporal Sequence: This was a cross-sectional study which involved the simultaneous measurement of exposure and outcome. Thus, it was not possible to know the temporal order in most instances.

Specificity: The associations with exposure are not specific for DMF, xylene and toluene and could be caused by many other agents or factors.

Coherence With Other Evidence: The associations are in general agreement with animal studies on these chemicals. While the exposures here are somewhat lower than the usual occupational situation, they are roughly of the same order of magnitude. The Silresim study also suggested that community exposures might produce effects at levels lower than might be expected in occupational settings.

Strength of Association: The magnitude of the odds ratios are from moderate (1.5 to 3.0) to strong (greater than 3.0). It is unlikely that an unknown confounder could account for this.

Biological Gradient: The positive associations are all for exposures taken as a continuous variable, hence show a biological gradient.

Statistical Significance: The use of tests of statistical significance insures that the observed associations are unlikely to be a result of chance fluctuations induced by random sampling.

In summary, the associations of acute and chronic health problems in adults and children, and of reproductive disorders with exposures to the factory emissions, are consistent with a causal relationship. No single study can establish conclusively that these emissions were responsible for any or all of the observed effects. However, the weight of the evidence and the potential seriousness of the health impacts confirms that the vigorous enforcement action recommended by DPH and undertaken by DEQE was appropriate. These results also suggest the need for a general policy covering non-criteria air-pollutants in Massachusetts.

Appendix 1
Health Effects of DMF, Toluene and Xylene

DME

N-N-Dimethyl formamide (DMF) is a colorless liquid that is a powerful solvent for many organic compounds. It is frequently used in operations where synthetic fabrics are being made, such as in the two facilities investigated in this report.

The OSHA standard is 10 ppm. 8-hour TWAs roughly five to ten times levels measured in the vicinity of the plants in this study.

Inhalation has been associated with gastrointestinal complaints, colicky abdominal pain, and, at high levels, liver damage. Renal damage has occurred in animal studies. Occupationally-exposed workers complain of fatigue, weakness and eye irritation. There is facial flushing with concurrent exposure to ethyl alcohol similar to the effect of alcohol and trichloroethylene. DMF is mutagenic in some *Salmonella* assays, and is a human wbc clastogen. Bioassays for carcinogenicity are negative to date.

Toluene

Toluene is a widely used industrial solvent. It causes irritation of the eyes and respiratory tract. At high levels it has CNS depressant effects, and symptoms of weakness and fatigue have been reported at levels of 100 ppm, roughly 100 times higher than reported in the high exposure areas of this study. High exposures also have produced a variety of gastrointestinal complaints. Liver damage and diffuse encephalopathy have been reported in chronic "glue-sniffers." Reproductive studies in animals have shown low birthweights, fetal wastage and cleft palate deformities at relatively high levels. The OSHA standard is 200 ppm, 8-hour TWA.

Xylene

Xylene is also a widely used industrial solvent, especially common in plastic materials fabrication. The OSHA standard is 100 ppm. Xylene vapors cause eye, nose and throat irritation, and, like toluene, can cause CNS depression at higher levels, as well as gastrointestinal complaints, such as nausea and abdominal pain. Minor reversible effects on liver and kidney have been reported.

APPENDIX 2

QUESTIONNAIRE

C165

February-April, 1983

FOR OFFICE USE

TRANSFER FROM HOUSEHOLD COVERSHEET:

1. INTERVIEWER: _____

6. CS #: _____

2. INTERVIEWER #: _____

7. _____
(ADDRESS)

3. INTERVIEW MODE: [] FIELD
[] PHONE

4. INTERVIEW DATE:
_____(MONTH) _____(DAY)

8. ADULT # _____ OF _____

5. INTERVIEW LENGTH:
_____(MINUTES)

9. [] PROXY INTERVIEW

10. RELATIONSHIP OF PROXY TO R:

:16-17

L O W E L L H E A L T H S T U D Y

Boston University School of Public Health
and the
Center for Survey Research
a facility of
The University of Massachusetts/Boston
and the
Joint Center for Urban Studies of M.I.T. and Harvard University

Confidential: No information shall be presented or published in any way that would identify any household or individual.

INTRODUCTION:

- a. MENTION CSR
- b. SPONSORSHIP - Commonwealth of Massachusetts
- c. PURPOSE - to learn more about the health of people living in Lowell - and about things in their lives that may affect their health.

Before we begin, there are a few points I need to cover.

1. I want to assure you that all information you give will be completely confidential and that none of it will be released in any way that would permit identification of you or your family.
2. Your participation in this study is, of course, voluntary.
3. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

TIME BEGUN: _____

A. HEALTH

I would like to begin with some questions about your health.

A1. Compared to most other people your age, is your health better than most,
about the same as most, or worse than most?

1 [] BETTER
2 [] ABOUT THE SAME
3 [] WORSE

1:18

A2. Overall, how would you rate your health - excellent, good, fair, or
poor?

1 [] - EXCELLENT
2 [] GOOD
3 [] FAIR
4 [] POOR

:19

A3. I am going to read a list of symptoms that people have. If I come to one that you have had in the past six months, let me know.

A4. Has this happened once AS. or twice, three or four times, or five or more times?

Did you see a doctor or some other health care provider about the problem?

	<u>NO</u>	<u>YES</u>	<u>ONCE/ TWICE</u>	<u>THREE/ FOUR</u>	<u>FIVE/ MORE</u>	<u>YES</u>	<u>NO</u>
--	-----------	------------	------------------------	------------------------	-----------------------	------------	-----------

In the past six months have you had:

IF YES,
ASK A4
AND A5

a. Wheezing or tightness in your chest

[2] [1] → [1]

[2]

[3]

[1]

[2]

b. Chest pain

[2] [1] → [1]

[2]

[3]

[1]

[2]

c. Nausea or vomiting

[2] [1] → [1]

[2]

[3]

[1]

[2]

d. Dizziness

[2] [1] → [1]

[2]

[3]

[1]

[2]

e. Shortness of breath

[2] [1] → [1]

[2]

[3]

[1]

[2]

In the past six months have you had:

f. Pins and needles or numbness in your fingers or toes

[2] [1] → [1]

[2]

[3]

[1]

[2]

g. Loss of consciousness or blackouts

[2] [1] → [1]

[2]

[3]

[1]

[2]

h. Swollen glands

[2] [1] → [1]

[2]

[3]

[1]

[2]

i. Diarrhea or constipation

[2] [1] → [1]

[2]

[3]

[1]

[2]

j. Rash or other skin irritation

[2] [1] → [1]

[2]

[3]

[1]

[2]

47 - 49

A3. Have you had any [A4
of these other OMITTED
symptoms in the HERE]
past six months?

A5. Did you see a
doctor or some
other health care
provider about
the problem?

<u>NO</u>	<u>YES</u>	<u>YES</u>	<u>NO</u>
-----------	------------	------------	-----------

IF YES,
ASK AS

k. Irritation or burning
in your eyes or nose

[2] [1] → [1] [2] 1:50-51

l. A cough lasting
two weeks or more

[2] [1] → [1] [2] :52-53

m. Irregular heart beat
or thumping-pounding
sensation in your
chest, not due to
exercise

[2] [1] → [1] [2] :54-55

n. A loss of at least
10 pounds without dieting

[2] [1] → [1] [2] :56-57

o. Always feeling tired
or fatigued

[2] [1] → [1] [2] :58-59

p. Nervousness

[2] [1] → [1] [2] :60-61

q. Acne

[2] [1] → [1] [2] :62-63

r. Unusual color urine

[2] [1] → [1] [2] :64-65

s. Extremely easy bruising
or unusual bleeding

[2] [1] → [1] [2] :66-67

A6. In the past six months have you seen a doctor or considered seeing a
doctor because of persistent colds?

1 [] YES

:68

2 [] NO

A7. In the past six months have you seen a doctor or considered seeing a
doctor because of headaches?

1 [] YES

:69

2 [] NO

:1-13 DUPLICATE

:14-15 1 2

I have been asking about symptoms you may have had in the last six months. These next questions are about health problems you have ever had in your life.

A8. Has a doctor or any other medical person ever told you that you have:

		<u>YES</u>	<u>NO</u>
:16	a. Anemia	[1]	[2]
:17	b. Other blood problems	[1]	[2]
:18	c. Kidney problems	[1]	[2]
:19	d. Lung or respiratory problems	[1]	[2]
:20	e. Neurologic or nervous system problems	[1]	[2]
:21	f. Skin disease or skin allergy	[1]	[2]
:22	g. Diabetes or "sugar" problems	[1]	[2]
:23	h. Hypertension or high blood pressure	[1]	[2]
:24	i. High cholesterol	[1]	[2]
:25	j. Liver problems such as cirrhosis, hepatitis, or jaundice	[1]	[2]
:26	k. Stomach problems or digestive disease	[1]	[2]

A9. Has a doctor or any other medical person ever told you that you have cancer?

:27 1 [] YES
 2 [] NO (SKIP TO A10)

A9a. What kind of cancer was it?

:28-29 _____ KIND OF CANCER

A9b. In what year did that happen?

:30-31 _____ YEAR

A10. Has a doctor or other medical person ever told you that you had heart trouble, such as a heart attack, angina, irregular heart beat, or something else?

1 [] YES

2:32

2 [] NO (SKIP TO A11)

A10a. What kind of heart problem were you told you had?

:33

_____ TYPE OF HEART PROBLEM

:34

A11. In the past six months have you had a health symptom or problem that I haven't mentioned that made you see a doctor or consider seeing a doctor?

1 [] YES

:35

2 [] NO (SKIP TO A12)

A11a. What is it?

(Any others?)

[LIST ALL REMAINING
MENTIONS HERE]

1. _____

2. _____

3. _____

4. _____

A11b.

1. Has this happened once or twice, three or four times, or five or more times?
[SYMPTOM 1]

2. Has this happened once or twice, three or four times, or five or more times?
[SYMPTOM 2]

1 [] ONCE OR TWICE

1 [] ONCE OR TWICE

2 [] THREE OR FOUR TIMES

2 [] THREE OR FOUR TIMES

3 [] FIVE OR MORE TIMES

3 [] FIVE OR MORE TIMES

A11c.

1. Did you see a doctor or some other health care provider about [SYMPTOM 1]?
2. Did you see a doctor or some other health care provider about [SYMPTOM 2]?

1 [] YES

1 [] YES

2 [] NO

2 [] NO

A12. Since June, have you been a patient in the hospital overnight for any reason?

2:48

1 [] YES
2 [] NO (SKIP TO A14)

A13. What were you hospitalized for?

:49-50

:51-52

A14. In the last two months have you seen a doctor or other health care provider for medical care or advice of any kind?

:53

1 [] YES
2 [] NO (SKIP TO A16)

A15. What was the reason you went for the last time? (Anything else?)

:54-55

:56-57

Now I have a few questions about smoking.

A16. Have you ever smoked cigarettes regularly?

:58

1 [] YES
2 [] NO (SKIP TO A23)

A17. At what age did you start smoking?

:59-60

_____ AGE

A18. Do you smoke now?

:61

1 [] YES
2 [] NO (SKIP TO A20)

A19. How many cigarettes do you smoke per day now?

PER DAY (SKIP TO A22)

:62-63

A20. At what age did you stop smoking?

AGE

:64-65

A21. About how many cigarettes did you smoke a day during most of the time while you were a smoker?

PER DAY (SKIP TO A23)

:66-67

A22. About how many cigarettes have you smoked a day during most of the time since you started to smoke?

PER DAY

:68-69

A23. Now, a few questions about drinking beer, wine, and liquor. Please think back over the past month and tell me how many days you had any wine, beer or liquor?

NUMBER OF DAYS

:70-71

00 [] NO DAYS (SKIP TO A25)

A24. On those days, when you had anything to drink about how many beers or glasses of wine or drinks of liquor did you usually have?

NUMBER

:72-73

A25. Has there ever been a time when you felt you had a drinking problem?

1 [] YES

:74

2 [] NO

A26. How much do you weigh now?

POUNDS

:75-77

A27. How tall are you?

FEET INCHES

:78-79

:1-13 DUPLICATE

:14-15 1 3

B. OCCUPATION HEALTH-INDIVIDUAL

We are interested in your present job status.

B1. Are you currently working at a job for pay?

1 [] YES

:16

2 [] NO (SKIP TO B3)

B2. Are you self employed or are you employed by someone else?

1 [] SELF EMPLOYED

:17

2 [] SOMEONE ELSE

B2a. What sort of work do you do on your job or what is your job title?

:18-19

B2b. Tell me a little more about what you do on your job?

B2c. What kind of business or industry is that in?

:20-21

B2d. [DON'T ASK IF CLEAR, BUT MARK ANSWER] Where do you do this work -
at home or away from home?

1 [] AT HOME

:22

2 [] AWAY FROM HOME

B2e. In what year did you start working there?

:23-24

YEAR (SKIP TO B5)

B3. Are you unemployed, laid-off, retired, on medical leave, disabled, a homemaker, student, some combination of these or something else?

1 UNEMPLOYED

2 LAID-OFF } (SKIP TO B5)

3 RETIRED

4 MEDICAL LEAVE

5 DISABLED

6 A HOMEMAKER

7 STUDENT

8 OTHER: (SPECIFY) _____

3:25

} (SKIP TO B4)

B3a. Why are you on medical leave?

:26

B3b. When did you first go on leave?

DATE (GO BACK TO B2)

:27-28

B4. Have you ever done any work for pay?

1 YES

2 NO (SKIP TO PAGE 15, B17)

:29

B5.

B6.

B7.

Smoke, Fumes,
or VaporsPesticides
or HerbicidesThings that
irritate your
eyes or nose

a. Have you ever had a job which exposed you to:

2 [] NO → 2 [] NO → 2 [] NO →

1 [] YES

1 [] YES

1 [] YES

7 [] DK

7 [] DK

7 [] DK

b. What was the last year you had a job which exposed you to:

YEAR
(SKIP TO B5e)

YEAR
(SKIP TO B6e)

YEAR
(SKIP TO B7e)

[] STILL IN IT

[] STILL IN IT

[] STILL IN IT

c. In your present job would you say you are exposed to this often, sometimes, or rarely?

1 [] OFTEN

1 [] OFTEN

1 [] OFTEN

2 [] SOMETIMES

2 [] SOMETIMES

2 [] SOMETIMES

3 [] RARELY

3 [] RARELY

3 [] RARELY

3:30-41

d. Have you had any other jobs which exposed you to:

2 [] NO
(SKIP TO B6)

2 [] NO
(SKIP TO B7)

2 [] NO
(SKIP TO B8)

1 [] YES

1 [] YES

1 [] YES

e. For about how many years total did you work in (another/a) job or jobs where you were exposed to:

YEARS

YEARS

YEARS

f. Over that time would you say you were exposed to this often, sometimes to rarely?

1 [] OFTEN

1 [] OFTEN

1 [] OFTEN

2 [] SOMETIMES

2 [] SOMETIMES

2 [] SOMETIMES

3 [] RARELY
(SKIP TO B6a)

3 [] RARELY
(SKIP TO B7a)

3 [] RARELY
(SKIP TO B8a)

42-53

88.

B9.-

B10.

B11.
Sandblasting,
Silica,
Rock crushing,
Drilling, or Talc

AsbestosBerylliumRadiation

[] NO → 2 [] NO → 2 [] NO → 2 [] NO

[] YES 1 [] YES 1 [] YES 1 [] YES

[] DK 7 [] DK 7 [] DK 7 [] DK

<u>YEAR</u> (SKIP TO B8e)	<u>YEAR</u> (SKIP TO B9e)	<u>YEAR</u> (SKIP TO B10e)	<u>YEAR</u> (SKIP TO B11e)
------------------------------	------------------------------	-------------------------------	-------------------------------

[] STILL IN IT [] STILL IN IT [] STILL IN IT [] STILL IN IT

[] OFTEN 1 [] OFTEN 1 [] OFTEN 1 [] OFTEN

[] SOMETIMES 2 [] SOMETIMES 2 [] SOMETIMES 2 [] SOMETIMES

[] RARELY 2 [] RARELY 2 [] RARELY 2 [] SOME

3:54-69

2 [] NO 2 [] NO 2 [] NO 2 [] NO
(SKIP TO B9) (SKIP TO B10) (SKIP TO B11) (SKIP TO B12)

[] YES 1 [] YES 1 [] YES 1 [] YES

<u>YEARS</u>	<u>YEARS</u>	<u>YEARS</u>	<u>YEARS</u>
--------------	--------------	--------------	--------------

[] OFTEN 1 [] OFTEN 1 [] OFTEN 1 [] OFTEN

2 [] SOMETIMES 2 [] SOMETIMES 2 [] SOMETIMES 2 [] SOMETIMES

[] RARELY 3 [] RARELY 3 [] RARELY 3 [] RARELY
(SKIP TO B9a) (SKIP TO B10a) (SKIP TO B11a) (SKIP TO B12a)

DUPLICATE : 1-13
1 4 : 14-15
 : 16-31

B12.
Solvants or
Degreasers
such as Perc
or Trichlor

B13.

Lead

B14.
Other metals
such as Mercury,
Cadmium,
or Arsenic

a. Have you ever had a job which exposed you to:

2 [] NO → 2 [] NO → 2 [] NO

1 [] YES

1 [] YES

1 [] YES

7 [] DK

7 [] DK

7 [] DK

b. What was the last year you had a job which exposed you to:

YEAR
(SKIP TO B12e)

YEAR
(SKIP TO B13e)

YEAR
(SKIP TO B14e)

[] STILL IN IT

[] STILL IN IT

[] STILL IN IT

c. In your present job would you say you are exposed to this often, sometimes, or rarely? 1 [] OFTEN
2 [] SOMETIMES
3 [] RARELY

1 [] OFTEN
2 [] SOMETIMES
3 [] RARELY

1 [] OFTEN

2 [] SOMETIMES

3 [] RARELY

3:32-43

d. Have you had any other jobs which exposed you to:

2 [] NO
(SKIP TO B13)

2 [] NO
(SKIP TO B14)

2 [] NO
(SKIP TO B15)

1 [] YES

1 [] YES

1 [] YES

e. For about how many years total did you work in (another/a) job or jobs where you were exposed to:

YEARS

YEARS

YEARS

f. Over that time would you say you were exposed to this often, sometimes or rarely? 1 [] OFTEN
2 [] SOME
3 [] RARELY
(SKIP TO B13a)

1 [] OFTEN

2 [] SOME

3 [] RARELY
(SKIP TO B14a)

1 [] OFTEN

2 [] SOME

3 [] RARELY
(SKIP TO B15)

44-55:

5. Have you ever had a job which included doing welding or soldering?

1 [] YES

4:56

2 [] NO

6. Have you ever had a job where you used vibrating equipment such as a jackhammer?

1 [] YES

:57

2 [] NO

17. Do you have any hobbies or things you often do in your spare time which involve contact with chemical substances like paint strippers, glues, art materials, varnishes, or welding materials?

1 [] YES

:58

2 [] NO

C. HOUSING - INDIVIDUAL

C1. INTERVIEWER CHECK (FROM COVERSHEET):

HAS ADULT LISTING BOX BEEN COMPLETED BY ANOTHER ADULT IN THIS HOUSEHOLD?

[] YES (SKIP TO C2)

[] NO

Cla. You told me there (is/are) _____ adult(s) living in your household. I need to list all the people age 18 or older living (here/there).

GO TO COVERSHEET AND COMPLETE COLUMNS A-E. THEN ASK Clb.

Clb. Are there any adults in your household who are temporarily away (like on a business trip), or any boarders whom we have not listed? (STUDENTS LIVING AWAY FROM HOME AT SCHOOL SHOULD NOT BE LISTED).

[] NO

[] YES (LIST THE ADDITIONAL ADULTS)

C2. INTERVIEWER CHECK (FROM COVERSHEET):

[] R IS 1ST INTERVIEW FROM HOUSEHOLD (SKIP TO C3)

[] R IS NOT 1ST INTERVIEW FROM HOUSEHOLD

C2a. We are interested in the places you have lived since 1970. Have you lived in the same home as [1st INTERVIEWED] since 1970?

1 [] YES (SKIP TO D1)

2 [] NO

C2b. In what year did you first start living with [1st INTERVIEWED]?

:60-61

YEAR [ENTER THIS YEAR IN C4]

C3. In what year did you first start living at your present address?

70 [] 1970 OR BEFORE (SKIP TO D1)

:62-63

YEAR AFTER 1970 →

ENTER THIS
YEAR IN C4

C4. We are interested in the places you have lived between
1970 and _____.
[YEAR FROM C2b OR C3]

IF R IS 1ST INTERVIEWEE, WHEN REACH YEAR ENTERED, ASK
"Is that when you moved to your present address?"

IF R IS NOT 1ST INTERVIEWEE, WHEN REACH YEAR ENTERED, ASK,
"Is that when you started living with [1ST INTERVIEWED]?"

YES (SKIP TO D1)
 NO (CONTINUE WITH SECTION C)

C5. In what city or
town were you
living in
(YEAR)?

[IF NOT
LOWELL,
CONTINUE
WITH C7]

C6. What was your
address (in
Lowell)? [WHEN
REACH R's PRESENT
ADDRESS, SKIP TO D1]

C7. In what year did you move
from there? [WHEN REACH YEAR
IN C4 OR IF R STILL LIVING
THERE, SKIP TO D1]

1970

1 LOWELL
2 NOT LOWELL

a. [USE THIS YEAR :16-20
YEAR IN C3b] _____

What city or town did
you move to in....

1 LOWELL
2 NOT LOWELL

b. [USE THIS YEAR :21-25
YEAR IN C4c] _____

1 LOWELL
2 NOT LOWELL

c. [USE THIS YEAR :26-30
YEAR IN C4d] _____

1 LOWELL
2 NOT LOWELL

d. [USE THIS YEAR :31-35
YEAR IN C4e] _____

1 LOWELL
2 NOT LOWELL

e. [USE THIS YEAR :36-40
YEAR IN C4f] _____

1 LOWELL
2 NOT LOWELL

f. [USE THIS YEAR :41-45
YEAR IN C4g] _____

1 LOWELL
2 NOT LOWELL

g. [USE THIS YEAR :46-50
YEAR IN C4h] _____

1 LOWELL
2 NOT LOWELL

:51-55

D. OPINION - INDIVIDUAL

The next questions are about the air and water in your neighborhood.

D1. We would like to know about the drinking water in your neighborhood. Have you ever noticed an unusual taste or smell in your water?

1 [] YES

5:56

2 [] NO

D2. Have you ever felt ill or had a health problem you believe was caused by the drinking water in your neighborhood?

1 [] YES

:57

2 [] NO

D3. What about the air in your neighborhood - has it ever had an unusual or unpleasant odor?

1 [] YES

:58

RECORD EXPLANATION OR DESCRIPTION
IF OFFERED. (DO NOT PROBE)

2 [] NO (SKIP TO D7)

D4. How often has this happened - has it happened often, occasionally, or only once or twice?

1 [] OFTEN

:59

2 [] OCCASIONALLY

3 [] ONLY ONCE OR TWICE

D5. Is the odor very strong, somewhat strong, or not very strong?

1 [] VERY STRONG

:60

2 [] SOMEWHAT STRONG

3 [] NOT VERY STRONG

D6. Are there particular weather conditions under which you notice this odor more often?

1 [] YES

5:61

2 [] NO (SKIP TO D7)

D6a. What are they?

:62

:63

D7. Have you ever felt ill or had a health problem that you believe was caused by the air in your neighborhood?

1 [] YES

:64

2 [] NO

E. BACKGROUND

Now, we would like some background information on you.

E1. What is the month and year of your birth?

5:65-66 MONTH YEAR

E2. Are you married, widowed, separated, divorced, or have you never been married?

1 [] MARRIED
2 [] WIDOWED
;67 3 [] SEPARATED
4 [] DIVORCED
5 [] NEVER BEEN MARRIED

E3. Which of these best describes your background - White, Black, Hispanic, American Indian, or Asian?

1 [] WHITE
2 [] BLACK
;68 3 [] HISPANIC
4 [] AMERICAN INDIAN
5 [] ASIAN

E4. What was the highest grade of school you completed? [IF HIGH SCHOOL OR COLLEGE: Did you graduate?]

1 [] 8TH GRADE OR LESS
2 [] 1-3 YEARS HIGH SCHOOL
3 [] HIGH SCHOOL GRADUATE
;69 4 [] 1-3 YEARS COLLEGE
5 [] COLLEGE GRADUATE
6 [] GRADUATE EDUCATION

E5. In 1982, was your total family income before taxes, more than \$15,000?

[] NO

[] YES

Was it more than \$10,000?

Was it more than \$25,000?

5:70

[] NO

[] YES

(SKIP TO F1)

[] NO

[] YES

Was it more than \$5,000?

More than \$20,000?

More than \$30,000?

[] NO

[] YES

[] NO [] YES

[] NO [] YES

1-13 DUPLICATE

14-15 1 6

F. WOMEN

F1. INTERVIEWER: OBSERVATION

R'S SEX:

1 [] MALE (SKIP TO PAGE 27, G1)
:16 2 [] FEMALE

F2. Have you ever been pregnant, even if it did not result in a live birth?

1 [] YES
:17 2 [] NO (SKIP TO PAGE 26, F17)

F3. How many children have been born to you?

:18-19 LIVE BIRTHS

F4. Did you end any of your pregnancies by getting an abortion?

1 [] YES
:20 2 [] NO (SKIP TO F5)

F4a. How many abortions have you had?

:21 ABORTIONS

F5. Have you ever had a miscarriage?

1 [] YES
:22 2 [] NO (SKIP TO F6)

F5a. How many miscarriages have you had?

:23 NUMBER OF MISCARRIAGES

F5b. What year was that? (When did you have (it/them)?)

<u>FIRST</u>	YEAR	6:24-25
<u>SECOND</u>	YEAR	:26-27
<u>THIRD</u>	YEAR	:28-29
<u>FOURTH</u>	YEAR	:30-31
<u>FIFTH</u>	YEAR	:32-33
<u>SIXTH</u>	YEAR	:34-35

F6. Have you ever had a stillbirth?

1	[] YES	:36
2	[] NO (SKIP TO F7)	

F6a. How many stillbirths have you had?

_____ NUMBER OF STILLBIRTHS :37

F6b. When did you have (it/them)? (What year was that?)

<u>FIRST</u>	YEAR	<u>SECOND</u>	YEAR
			
F6c. What sex was the baby?		F6d. What sex was the baby?	
1	[] BOY	1	[] BOY
2	[] GIRL	2	[] GIRL
7	[] DK	7	[] DK

:38-43

F7. INTERVIEWER CHECK (FROM F3):

1 [] R HAS HAD NO LIVE BIRTHS (SKIP TO F17)

6:44
2 [] R HAS HAD LIVE BIRTHS

We would like to ask about each of the children born to you.

F8. When was your (first child, second child, etc.) born?

F9. Was child a boy or a girl?

F10. How much did the baby weigh?

F11. Did you smoke cigarettes during the pregnancy?

	<u>MO</u>	<u>YR</u>	<u>BOY</u>	<u>GIRL</u>	<u>LB</u>	<u>OZ</u>	<u>NO</u>	<u>YES</u>	[IF NO, SKIP TO F13]
1st			[1]	[2]			[2]	[1] →	
2nd			[1]	[2]			[2]	[1] →	
3rd			[1]	[2]			[2]	[1] →	
4th			[1]	[2]			[2]	[1] →	
5th			[1]	[2]			[2]	[1] →	
6th			[1]	[2]			[2]	[1] →	
7th			[1]	[2]			[2]	[1] →	
8th			[1]	[2]			[2]	[1] →	
9th			[1]	[2]			[2]	[1] →	
10th			[1]	[2]			[2]	[1] →	

<u> </u>	6:45-80
<u>DUPLICATE</u>	7:1-13
<u>1</u> <u>7</u>	:14-15
<u> </u>	:16-69

F12. About how many cigarettes did you smoke a day?

F13. Is this child still alive?
 [IF YES, GO
 TO NEXT CHILD
 (F8) OR F16]

F14. How old was he/she when he/she died?

F15. What did he/she die of?

<u>CIGARETTES/DAY</u>	<u>YES</u>	<u>NO</u>	<u>AGE</u>	<u>CONDITION</u>
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____
_____	[1]	[2]	_____	_____

<u>DUPLICATE</u>	8:1-13
<u>1</u> <u>8</u>	:14-15
<u> </u>	:16-69
<u>DUPLICATE</u>	9:1-13
<u>1</u> <u>9</u>	:14-15
<u> </u>	:16-51

F16. [Was your child/Were any of your children] born prematurely?

1 [] YES

9:52 2 [] NO

(SKIP TO F17)

7 [] DK

F16a. [ASK IF R HAS MORE THAN ONE CHILD] Which ones?

PREMATURE CHILDREN
(1ST, 2ND, ETC.)

F17. Have you had a hysterectomy?

1 [] YES (SKIP TO F19)

:53 2 [] NO

F18. Have you experienced or are you experiencing menopause or change of life?

1 [] YES

:54 2 [] NO (SKIP TO F19)

F18a. When did it start?

:55-56 _____ YEAR

F19. Have you ever had a problem with infertility - that is a year or more when you were trying to get pregnant but were unable to?

1 [] YES

:57 2 [] NO (SKIP TO G1)

F19a. When did this first occur?

:58-59 _____

G. HOUSEHOLD INFORMATION

G1a. INTERVIEWER CHECK (FROM COVERSHEET, COLUMN G)

HAS THE HOUSEHOLD DATA BEEN GIVEN BY ANOTHER ADULT? (i.e. IS THERE A IN COLUMN G?)

1 [] YES (SKIP TO PAGE 29, H1)

9:60

2 [] NO (ENTER CHECK IN COLUMN G AND GO TO G2)

CODER: K1-K3 :61-63

DUPLICATE :1-13

0 1 :14-15

G2. [ASK IF PHONE; FILL OUT BY OBSERVATION IF IN PERSON] Do you live in a single family house, a two or three family home, an apartment or flat, a mobile home, or what?

1 [] HOUSE

2 [] TWO OR THREE FAMILY HOME

3 [] APARTMENT OR FLAT (4 OR MORE UNITS IN BUILDING) :16

4 [] MOBILE HOME

[] OTHER: (SPECIFY) _____

G3. Do [you/members of your household] drink only tap water, only water you buy or bring home in bottles, or both tap water and other water?

1 [] ONLY TAP WATER (SKIP TO G4)

:18

2 [] ONLY OTHER WATER YOU BUY OR BRING HOME

:17

3 [] BOTH TAP WATER AND OTHER WATER.

:19

G3a. Why do you not just drink tap water?

G4. Since living in your present home, have you had any dogs?

1 [] YES

10:20

2 [] NO (SKIP TO H1)

G5. Have you had any dogs die since living there?

1 [] YES

:21

2 [] NO (SKIP TO H1)

G5a. How many?

:22

_____ NUMBER

G6. Did [any of them/your dog] die of an illness, other than old age or an accident?

1 [] YES

:23

2 [] NO (SKIP TO H1)

G7. What kind of illness/illnesses? [IF MORE THAN 3, RECORD 3 MOST RECENT]

1. _____

2. _____

3. _____

G8a. 1. When did that occur?

_____ YEAR

2. When did that occur?

_____ YEAR

3. When did that occur?

_____ YEAR

24-32: _____

H. CHILDREN

H1a. INTERVIEWER CHECK (COVERSHEET, ITEM 5):

CHILDREN LIVING IN HOUSEHOLD:

YES

NO (SKIP TO PAGE 36, J1)

H1b. INTERVIEWER CHECK (COVERSHEET, COLUMN F):

CHILD INFORMATION HAS BEEN OBTAINED

YES (SKIP TO PAGE 36, J1)

NO

H1c. I need to ask about the health of any children presently living in the household. Can you provide me with this information?

YES (ENTER 'YES' IN COLUMN F AND GO TO H2)

NO (SKIP TO PAGE 36, J1)

H2. Could you tell me the first name, the age and the sex of each child living with you who is less than 18 years old? Let us start with the oldest.

	<u>NAME</u>	<u>AGE</u>	<u>SEX</u>
A	_____	____ YRS	[M] [F]
B	_____	____ YRS	[M] [F]
C	_____	____ YRS	[M] [F]
D	_____	____ YRS	[M] [F]
E	_____	____ YRS	[M] [F]
F	_____	____ YRS	[M] [F]
G	_____	____ YRS	[M] [F]

[SAY IF R MENTIONS ANY CHILDREN NOT LIVING AT HOME]

The questions I am going to ask now are about the health of the children who are living at home with you.

H3. [Has your child/have any of your children] ever been diagnosed by a doctor as having

H4. [IF MORE THAN ONE CHILD IN HH] H4a. In what year did Which child was that? this first start?

	<u>NO</u>	<u>YES</u>	<u>NAME/CHILD</u>	<u>YEAR</u>
a. Epilepsy	[2]	[1] →	_____	_____
b. Asthma	[2]	[1]	_____	_____

H5. [Has your child/Have any of your children] ever had bronchitis three or more times within a single year?

1 [] YES

2 [] NO (SKIP TO H6)

H5a. [ASK IF MORE THAN ONE CHILD IN HH] What child was that?

H5b. In what year(s) did this happen?
[RECORD FIRST YEAR MENTIONED]

YEAR

YEAR

YEAR

H6. Has a teacher or doctor ever told you that [your child/one of your children] has a learning disability, hyperactivity, mental retardation, hearing loss, or was not developing normally?

1 [] YES

2 [] NO (SKIP TO H7)

H6a. [ASK IF MORE THAN ONE CHILD IN HH] Which child was that?

H6b. What problem were you told he/she had?

H6c. When did this happen?

a. _____

b. _____

c. _____

YEAR

YEAR

YEAR

H7. Children often get earaches. [Have any of your children/has your child] had more than two earaches in the past two months?

1 [] YES

2 [] NO (SKIP TO H8)

H7a. [ASK IF MORE THAN ONE CHILD IN HH] Which child was that?

a. _____

b. _____

c. _____

H8. Children also tend to get sore throats. [Have any of your children/has your child] had more than two sore throats in the past two months?

1 [] YES

2 [] NO (SKIP TO H9)

H8a. [ASK IF MORE THAN ONE CHILD IN HH] Which child was that?

a. _____

b. _____

c. _____

H9. [Have any of your children/has your child] had frequent colds in the past year?

1 [] YES

2 [] NO (SKIP TO H10)

H9a. [ASK IF MORE THAN ONE CHILD IN HH] Which child was that?

a. _____

b. _____

c. _____

H10. [Has your child/Have any of your children] ever been diagnosed by a doctor as having a birth defect?

1 [] YES

2 [] NO (SKIP TO H11)

H10a. [ASK IF MORE THAN
ONE CHILD IN HH]
Which child?

H10b. What was the
birth defect?

a. _____

b. _____

c. _____

H11. [Has your child/Have any of your children] ever been diagnosed by a doctor as having bone problems, blood problems, lung problems, skin disease, glandular problems or something else which is not one of the common childhood illnesses?

1 [] YES

2 [] NO (SKIP TO H12)

H11a. [ASK IF MORE THAN
ONE CHILD IN HH]
Which child?

H11b. What was he/she
diagnosed as having?

H11c. In what year did
this happen?

a. _____

YEAR

b. _____

YEAR

c. _____

YEAR

H12. INTERVIEWER CHECK (FROM CHILDREN'S LISTING):

1 [] R HAS CHILDREN 5 YEARS OR YOUNGER
2 [] R HAS CHILDREN 6 YEARS OR OLDER (SKIP TO H14)

H13. [Does your child/do any of your children under 5] regularly attend nursery school, day care, play group, or some kind of child care with two more other children who don't live with you either in your home or away from home?

1 [] YES
2 [] NO

H13a. [ASK IF MORE THAN ONE CHILD IN HH] Which child is that?

a. _____
b. _____
c. _____

H14. INTERVIEWER CHECK:

[] R HAS NO CHILDREN OVER 5 (SKIP TO H17)
[] R HAS CHILDREN 6 YEARS OR OLDER

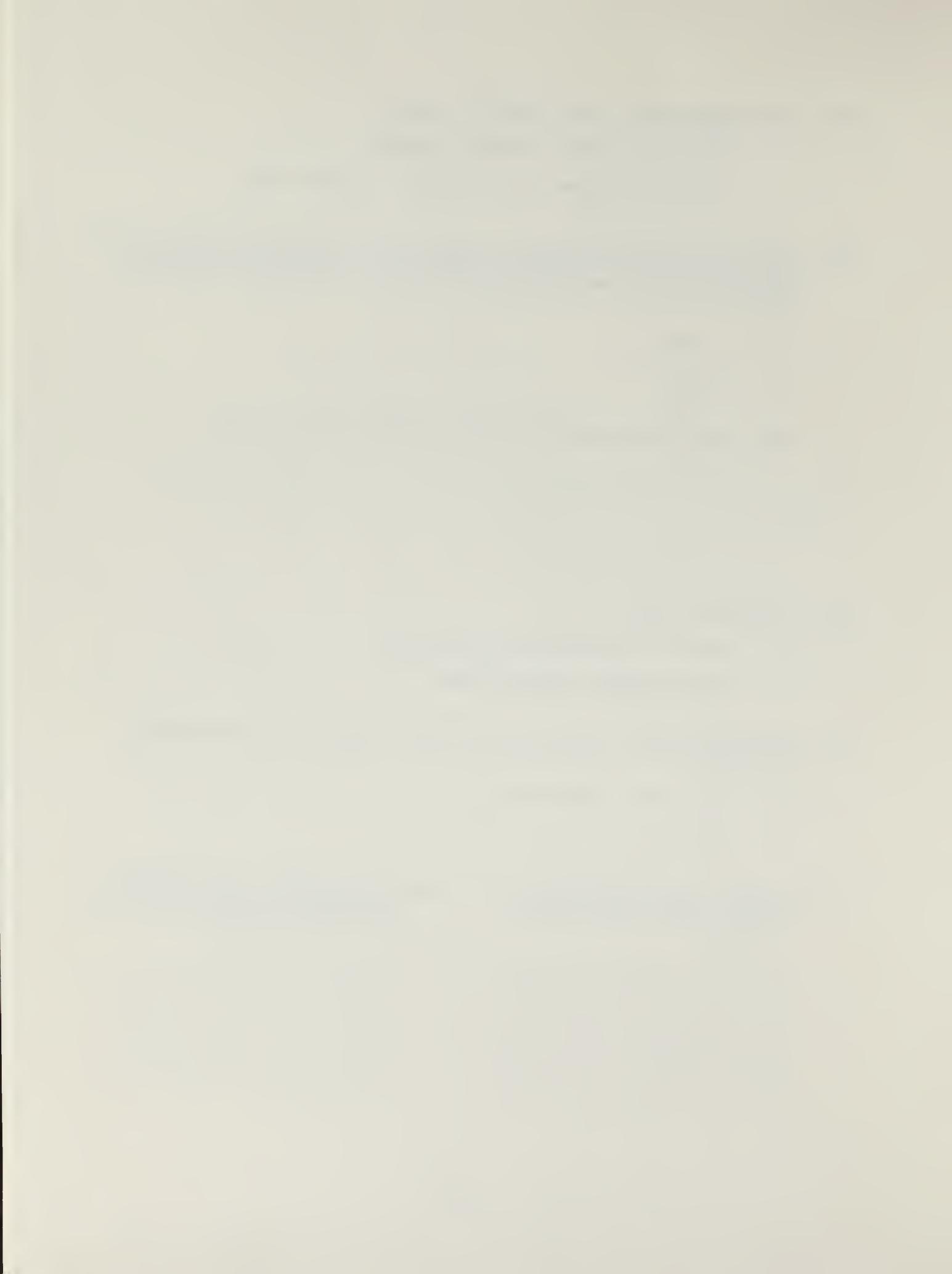
H15. [Are all of your children over 5/Is your child] able to go to school regularly?

1 [] YES (SKIP TO H16)
2 [] NO

H15a. [ASK IF R HAS MORE THAN ONE CHILD] Which child/children is that?

a. _____
b. _____
c. _____
d. _____

H15b. [ASK FOR EACH CHILD LISTED IN H15a] Why is he/she unable to go to school regularly?



H16. Most children get sick and miss some school each year because of illness.
[Have any of your children/Has your child] missed school because of
illness more often than you consider to be average this year?

1 [] YES

2 [] NO (SKIP TO H17)

H16a. [ASK IF R HAS
MORE THAN ONE
CHILD] Which
child is that?

a. _____

b. _____

c. _____

d. _____

H16b. About how many
days of school
has he/she missed
since September?

H17. [Do any of your children/Does your child] have health problems or a physical condition which limits the amount or type of physical activity they can do?

1 [] YES

2 [] NO (SKIP TO J1)

H17a. [ASK IF R HAS MORE THAN ONE
CHILD] Which child/children
is that?

a. _____

b. _____

c. _____

d. _____

e. _____

H17b. [ASK FOR EACH CHILD LISTED IN
H17] What health condition limits
[his/her] activity?

TIME ENDED: _____

SECTION J: FOUND HOUSING UNITS, INTERVIEWING
OTHERS IN THE HOUSEHOLD

J1. INTERVIEWER CHECK (FROM COVERSHEET, COLUMN H):

[] R IS NOT THE FIRST PERSON INTERVIEWED (SKIP TO J4)
[] R IS THE FIRST PERSON INTERVIEWED

J2. INTERVIEWER CHECK (FROM COVERSHEET LABEL):

[] NO "SHU" DESIGNATION ON LABEL (SKIP TO J4)
[] "SHU" IS DESIGNATED ON LABEL

J3. Besides the adults in your household, are there any other adults who live at this address, but who live in a separate apartment?

[] NO (CHECK NONE IN ITEM 1a ON COVERSHEET AND SKIP TO J4)
[] YES

J3a. We didn't know there was another household here. We would like to include them also in our study. Can you give me whatever information you can to help us send them a letter and get in touch with them?

NAME
ADDRESS RECORD INFORMATION IN ITEM 1 OF PINK COVERSHEET
TELEPHONE

TRY TO OBTAIN NAME AND ADDRESS FOR MAILING R LETTER AND TELEPHONE NUMBER FOR INTERVIEWING. AT A MINIMUM, OBTAIN A DESCRIPTION OF THE PHYSICAL LOCATION OF APARTMENT FOR AN INTERVIEWER TO VISIT.)

COPY COVERSHEET NUMBER FROM BLUE COVERSHEET LABEL TO ITEM 1 OF PINK COVERSHEET.

(RECORD ANY INFORMATION ABOUT COMPOSITION OF THIS FOUND HOUSING UNIT ON PAGE 2 OF PINK COVERSHEET UNDER "ADDITIONAL COMMENTS").

(RECORD THE NUMBER OF FOUND HOUSING UNITS IN ITEM 1a OF BLUE HOUSEHOLD COVERSHEET.)

J4. INTERVIEWER CHECK (FROM COVERSHEET, ITEMS 6 AND 7):

- ONE ADULT IN HOUSEHOLD (SKIP TO J8)
- ALL HOUSEHOLD MEMBERS HAVE FINAL RESULTS (COLUMN H) - (SKIP TO J8)
- OTHER HOUSEHOLD MEMBER(S) TO BE INTERVIEWED

J5. We would like to interview the other adults in the household.

Is/are _____ available?

(ADULT(S) FROM LISTING BOX)

- YES (INTERVIEW THE ADULT)
- NO - PHONE INTERVIEW (SKIP TO J7)
- NO - FIELD INTERVIEW

J5a. FIELD INTERVIEW: We would like to interview the other adults in your household by telephone. May we please have your phone number?

- TELEPHONE # OBTAINED (ENTER TELEPHONE NUMBER ON LABEL OF BLUE HOUSEHOLD COVERSHEET, ITEM 1 AND SKIP TO J7)
- R REFUSED TELEPHONE #
- NO TELEPHONE IN HOUSEHOLD

J6. We need to interview all of the adults in your household. When would be a good time to return to interview [this person/these people]?

(RECORD APPOINTMENT INFORMATION ON COVERSHEET AND SKIP TO J8)

J7. When would be a good time to call (back) to reach [this person/these people]?

(RECORD APPOINTMENT INFORMATION, ALONG WITH CALL# AND ADULT # IN "APPOINTMENTS", PAGE 4 COVERSHEET, ITEM 10.)

J8. Thank you very much for your help on this study.

(RECORD INTERVIEW IN COLUMN H AND ALSO COMPLETE CALL RECORD ON P2 COVERSHEET. CALL CSR WITH FINAL RESULT INFORMATION.)

Appendix 3

Letters and Fact Sheets

INTERVIEWER OBSERVATIONS

K1. HOW COOPERATIVE WAS R?

- 1 [] COOPERATIVE
- 2 [] NEUTRAL
- 3 [] ANTAGONISTIC

K2. OVERALL, HOW WAS R'S INTEREST IN THE INTERVIEW?

- 1 [] VERY INTERESTED
- 2 [] INTERESTED
- 3 [] INDIFFERENT
- 4 [] NEGATIVE, DEFENSIVE, UPSET

K3. LANGUAGE INTERVIEW WAS TAKEN IN?

- 1 [] ENGLISH
- 2 [] PORTUGUESE
- 3 [] SPANISH
- 4 [] OTHER (SPECIFY): _____

Center for Survey Research

100 Arlington Street, Boston, Massachusetts 02116 · (617) 956-1150

Dear Resident of Lowell:

We need the benefit of your experience and hope you will help us. We are carrying out an important study sponsored by the Commonwealth of Massachusetts.

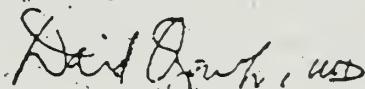
Your household is one of about 1200 in Lowell selected as part of a scientific sample in the City of Lowell for a study of health and the experiences which may affect health.

An interviewer will be calling or visiting your home within the next few weeks to ask to speak with the adults in your household.

There is an information sheet enclosed which may answer questions you have; your interviewer will be glad to answer additional questions.

Let me just assure you of three points. First, although your help is, of course, voluntary, the sample method makes the cooperation of each selected household very important to producing accurate data. Second, your answers are strictly confidential. Third, by giving your time you will be contributing to a project that will be very valuable to the community of Lowell and for people in other cities.

Sincerely,



David M. Ozonoff, M.D.



Mary Ellen Colten, Ph.D.

INFORMATION SHEET
LOWELL HEALTH STUDY

Who is doing the study? The study is being conducted by the Center for Survey Research of the University of Massachusetts and the School of Public Health of Boston University. The Commonwealth of Massachusetts is sponsoring the study.

What is this study for? We are trying to learn more about the health of people in Lowell and about things in their lives which may affect their health -- such as where they have lived and what kind of work they have done.

How were households selected? A sample of over 1200 households in various sections of Lowell were selected. Within each section each household had an equal chance of being chosen. The scientific method used means that information from each household selected is important to the accuracy of the research. Once a selection is made we can make no substitutions. It is important to be sure that the people interviewed as a group represent the residents of the area.

Who in the household will be interviewed? The interviewer will ask to speak separately with each adult in your household. The interview will take about 20 minutes of your time.

Who will see my answers? Your answers are completely confidential. Your name will not be attached to your answers. The only people who will see your answers to the questions will be the scientists working on the study and their assistants. When we present what we found from the study, we report what groups of people said as a whole. When the results are reported, everyone's answers will be put together so that no information is given that would allow someone to be identified. We will report things like, "46% of the residents of Lowell told us that ...".

What kinds of questions will be asked? The questions are about your health, your current health, some past health problems, health services you have used, and the things you do that may affect your health, such as what kind of work you do, what kinds of hobbies you have, and where you have lived. They are questions you can answer easily, but the answers taken together provide data that cannot be obtained in any other way. Most people find the questions interesting. However, you may ask the interviewer to skip a question if there is any one you do not want to answer.

What if I have questions? Your interviewer will be happy to answer your questions, or you can call Margaret Raisty in our Field Office at 956-1150.

ADDITIONAL INFORMATION:

Why was Lowell chosen? Because the state is concerned about health problems that are typical of industrial cities like Lowell.

Benefits of the Study. The information will be used by the Commonwealth of Massachusetts in deciding what to do about the problems of people in cities like Lowell.

Where will the data be available? The Massachusetts Department of Public Health and the Department of Environmental Quality Engineering will have a report available by the end of this year.

Center for Survey Research

P.O. Box 1000, Belmont, Massachusetts 02116 • (617) 966-1150

Caríssimo Residente de Lowell:

Necessitamos que nos ajude com a sua experiência e esperamos obtê-la. Estamos levando a efeito um estudo importante patrocinado pelo Governo de Massachusetts.

A vossa casa é uma das 1200 em Lowell seleccionadas como parte dumha amostra científica da cidade de Lowell para um estudo sobre saúde e factores que possam de qualquer forma afectar a saúde.

Um empregado nosso vai chamar ou visitar a vossa casa dentro em pouco para fazer algumas perguntas aos adultos que aí moram.

Junto segue uma folha com informação que talvez seja a resposta a algumas perguntas que queira fazer; a pessoa que vai proceder à entrevista terá muito prazer em responder a quaisquer perguntas adicionais.

Permita-me que lhe dê a certeza de 3 coisas: Primeiro, embora a vossa ajuda seja certamente voluntária, o método de exemplo ou amostra torna muitíssimo importante a cooperação de cada casa escolhida, no aspecto de apresentar informação exacta. Segundo, as vossas respostas são absolutamente confidenciais. Terceiro, a dádiva do vosso tempo irá contribuir para um projecto que trará muito valor à comunidade de Lowell e às populações de outras cidades.

Sinceramente,

David M. Ozonoff, Ph.D.



Mary Ellen Colten, Ph.D.



FOLHA DE INFORMAÇÃO
ESTUDO DE SAÚDE DE LOWELL

Quem está procedendo ao estudo? O estudo está sendo levado a efeito pelo Centro de Pesquisa da Universidade de Massachusetts e pela Escola de Saúde Pública da Universidade de Boston. O Governo de Massachusetts concorre com as despesas deste programa.

Para que é este estudo? Estamos tentando saber mais acerca da saúde da população de Lowell e acerca de coisas que poderão afectar a sua saúde -- tais como onde têm vivido e que especie de trabalho tem feito.

Como é que as casas foram escolhidas? Uma amostra de mais de 1200 lares em várias secções de Lowell foi seleccionada. Dentro de cada secção, cada lar teve a mesma oportunidade de ser escolhido. O método científico usado significa que a informação de cada casa escolhida é importante para a exactidão da pesquisa. Uma vez que uma selecção é feita, nós não podemos fazer substituições. É importante ter a certeza de que as pessoas entrevistadas como um grupo representam os residentes da área.

Quem vai ser entrevistado em cada lar? A pessoa que vos vai entrevistar pedirá para falar a sós com cada adulto do vosso lar. A entrevista levará aproximadamente 20 minutos.

Quem vai ver as minhas respostas? As vossas respostas são absolutamente confidenciais. O vosso nome não será posto nas vossas respostas. As únicas pessoas que vão ler as respostas serão os cientistas trabalhando neste estudo e os seus assistentes. Quando nós apresentarmos o resultado do nosso estudo, estaremos apresentando o que disseram grupos de pessoas como "um todo". Assim, as respostas de toda a gente serão postas juntas de tal modo que nenhuma informação poderá ser identificada. Ao divulgarmos o resultado deste estudo será, por exemplo, do seguinte modo: "46% dos residentes de Lowell disseram-nos que..."

Que espécie de perguntas serão feitas? As perguntas serão sobre a vossa saúde, a saúde actual, alguns problemas de saúde do passado, Serviços de Saúde que tenham usado e as coisas que tenham feito que possam ter afectado a vossa saúde, tais como o trabalho, os passatempos e onde têm vivido. São perguntas a que podereis responder facilmente, mas as respostas colocadas juntas dar-nos-ão informação que de outro modo não poderia ser obtida. A maior parte das pessoas acha as perguntas interessantes. No entanto podem pedir para não responder a certas perguntas se entenderem que o não devem fazer.

E se eu quizer também fazer perguntas? Quem vos vai entrevistar terá muito prazer em responder às vossas perguntas, ou então pode-reis chamar Margaret Raisty, telefone 956 1150, no nosso Field Office.

Center for Survey Research

109 Arlington Street, Boston, Massachusetts 02110 (617) 556-1150

Dear Resident of Lowell:

Recently, one of our interviewers asked the adult members of your household to participate in the health study of Lowell being conducted by the Boston University School of Public Health and the Center for Survey Research. At that time, one or more of you indicated that you would rather not be interviewed.

Sometimes people feel this way because of certain concerns they have about these kinds of interviews. Because having the benefit of your experiences and opinions is very important, we would like to take this opportunity to give you some additional information about the study.

Many people wonder how their household was selected. Your household was selected as part of a scientific sample of households in Lowell. The study, which is funded by the Commonwealth of Massachusetts, has been designed to answer certain important questions about community health in highly industrialized cities like Lowell. Only by interviewing every adult in each of the selected households can we be sure that our findings actually represent the health experiences of people in Lowell.

Your participation, of course, is entirely voluntary. If, after starting the interview, there are questions you do not care to answer you may ask the interviewer to skip them. However, your participation is very important to our study and to the accuracy of the results.

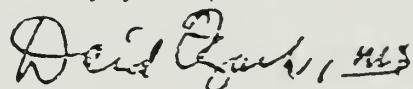
Let me assure you again that all responses are kept in the strictest confidence. No information will be released that can identify anyone taking part in the study.

We hope that you might reconsider your participation in this study. The interview is not lengthy. Most people have found it to be a worthwhile and enjoyable experience.

In the near future, an interviewer will contact you again to ask for your participation, and if you wish, arrange for a convenient time to talk to you.

Thank you for your time and consideration.

Sincerely yours,



David M. Ozonoff, M.D.



Mary Ellen Colten, Ph.D.

Appendix 4

**Majilite and Compo Stack Parameters
Used in Air Modelling**

TABLE 1

Stack Parameters at Maximum Capacity for DMF Emitting Sources at Compo Industries, Inc., in Lowell¹

	Stack C1 eng. metric	Stack C5(1) eng. metric	Stack C5(2) eng. metric
Height (above ground)	60 ft.	18.3 m	5 ft.
Height (above ground)	43 ft.	13.1 m	5 ft.
Diameter	3.8 ft.	1.16 m	.61 m
Flow Rate ²	25400 SCFM	14.5 m ³ /sec.	6540 SCFM 4.0 m ³ /sec.
Velocity	2200 ft/min	—	2240 ft/min
Exit Temp (Winter)	100°F	180°F	—
Exit Temp (Summer)	100°F	220°F	377°F
Emissions (Peak hour)	620 #/hr.	78.2 g/sec.	12.6 g/sec.
Emissions (Average hour)	425 #/hr.	68 #/hr.	25 #/hr.

¹ Supplied by DEQE Northeast Regional Offices.

² Note that metric flow rate in m³/sec was calculated by converting SCFM to m³ and adjusting standard conditions of 68°F and 30 inches of Ng were assumed.

TABLE 2

Stack Parameters at Maximum
Capacity for DMF Emitting Sources
from Majelite Corporation, In Lowell

	Stack One eng. metric	Stack Two eng. metric	Stack Three eng. metric	Stack Four eng. metric
Height (above ground)	32 Ft.	9.75m	32 ft.	9.75 m
Diameter ⁴ (inside)	-	.49m ²	-	.74 m ²
Exit Velocity	-	29.9 m/sec	-	4.8 m/sec
Vol. Flow ²	12000 ACFM	5000 ACFM	5000 ACFM	5000 ACFM
Exit Temp	91°F	305°K	138°F	143°F
Emission Rate ³	49.2 # hr.	6.2 g/sec	49.2 # hr.	6.2 g/sec
Stack Area	14"x21"	-	20"x38"	-
			21"x32"	-
			21"x32"	-

1 Supplied by DEQE Northeast Regional Offices.

2 Note that metric flow rate in m³/sec was calculated by converting SCFM to m³ and adjusting for temperature. Standard conditions of 68°F and 30 inches of Hg were assumed.

3 Stack one and two (combined) emit 198#/hr of 49.3% DMF. Stacks three and four (combined) emit 180#/hr of 30.8% DMF.

4 Equivalent circular diamters.

